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Criteria of Malignancy[1]

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WERE IT POSSIBLE to conceive of but a single type of neoplasm, involving a particular part of a standard host, there would be no great difficulty in formulating a fairly uniform and satisfactory set of rules or criteria for the recognition of its presence (diagnosis). A relatively simple terminology could be utilized in giving it a name (classification). It might be expected to give rise to reasonably uniform sequelae (symptomatology). Its ultimate effects upon the host might be reasonably uniform in cases running their natural course (prognosis). Methods for its elimination might be uniform and standardized (treatment). Even if these aspects could be reduced so simply, there would remain the problem of the causation of the neoplasm (etiology), its possible functions (pathologic physiology), its gross characteristics (pathologic anatomy), and its structure (histology and cytology).

Many of the foregoing aspects of neoplasms are concerned with objective phenomena or qualities which can be observed, studied, correlated, and evaluated, and to this extent are subject to rationalization, understanding, and agreement. Other aspects are of a more philosophical nature and are subject to interpretations which may be valid or fallacious. Herein lies one of the difficulties in the establishment of a generally and finally acceptable definition of what constitutes a neoplasm.

To introduce only one additional factor, namely, the conception of a benign as opposed to a malignant neoplasm, greatly complicates many of the foregoing considerations and imposes upon us the necessity of establishing criteria for distinguishing between benign and malignant tumors.

The distinction between a benign and a malignant neoplasm of a particular type—for example, one of connective tissue origin—is at times difficult to make. This difficulty is greatly magnified by the fact that we have not a single type of neoplasm, but dozens of different kinds, of several arbitrary degrees of malignancy, involving dozens of different locations, and giving rise to dozens of different sets of variable consequences, in the natural course of events.

On the basis of accumulated experience, it is generally accepted that as long as a neoplasm remains local, causes no untoward symptoms, does not impair the general health, does not invade locally or disseminate itself to distant parts, and does not cause death, it may be said to be benign. Conversely, if it grows rapidly, causes symptoms, impairs health, invades or destroys, gives rise to secondary growths elsewhere, and finally causes the death of the host, it is said to be malignant.

Many of the foregoing phenomena are of a general nature and may be looked

[1] Presented before the Radiological Society of North America, at the Twenty-sixth Annual Meeting, Cleveland, Ohio, Dec. 2–6, 1940.

upon as manifestations, complications, or sequelae of the neoplasm. When present, they constitute criteria sufficiently reliable, in many instances, for the recognition of the fact of malignancy, without recourse to a detailed examination of the neoplasm itself. When they are absent there is only one other source of information from which to establish criteria of malignancy, and that is a study of the neoplasm itself.

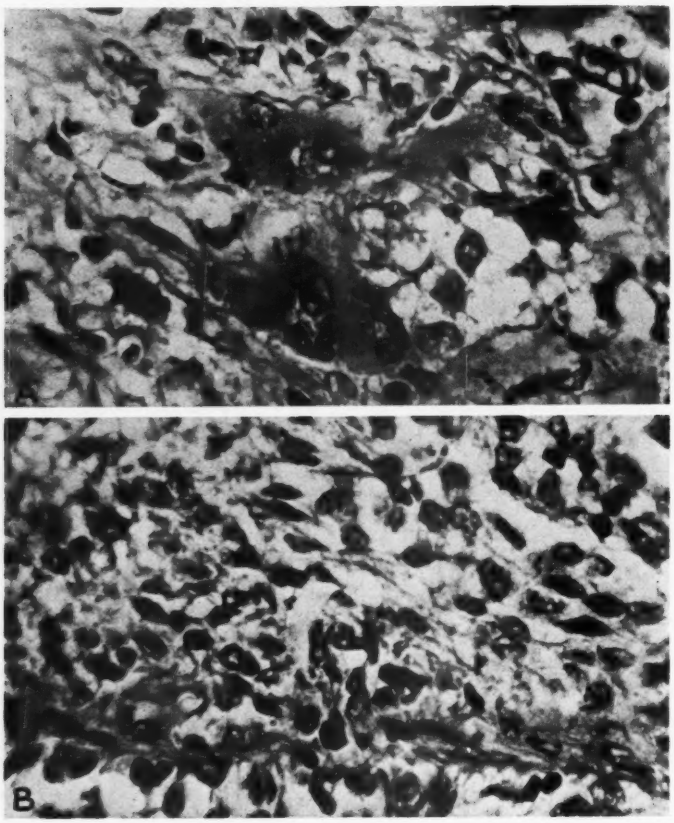

Fig. 1. Rhabdomyosarcoma of the leg.
A. The origin of the neoplasm is disclosed by the presence of identifiable muscle cells.
B. In other parts of the neoplasm the cells are too undifferentiated to be recognized as muscle cells. Needle or other biopsies from such areas would not reveal the nature of the growth. × 480.

PATHOLOGIC CRITERIA OF MALIGNANCY

The pathologist bases his conception of malignancy largely, but not exclusively, upon the objective findings in the neoplasm itself. The criteria he applies to determine whether or not a certain mass is a neoplasm and, if so, whether or not it is malignant, must be applicable to any and all stages of the process irrespective of its origin and location, and with or without any other manifestations than the presence of a mass. They must be applicable whether or not the neoplasm has invaded or metastasized, and whether the host be living or dead.

Every effort is made by the pathologist to identify the parent cell type from which the neoplasm originated. This is comparatively easy in neoplasms of adult type in

which the state of maturity approaches that of the normal parent tissue (Fig. 1-A). The identification becomes increasingly difficult as the tumor cells depart from the adult type and revert toward the embryonal type (Fig. 1-B). This may proceed to such a degree that it becomes practically impossible, from a purely objective standpoint, to identify the parent cell. Under certain circumstances it is practically impossible to distinguish between a fat cell, a lymphoid cell, a connective-tissue cell, a cartilage cell, and a bone cell (Fig. 2). At times it is practically impossible to distinguish between a connective-tissue cell and an epithelial cell (Fig. 3). They all come from the same stem if one goes back far enough in the embryological scale. Herein lies one of the difficulties in the classification of neoplasms into types.

All organs and tissues have an architectural plan which is looked upon as being normal. Any derangement of this plan immediately raises the question of either a benign or malignant neoplastic process. Growth of the epithelial cells of the skin outward, to form villus-like processes, usually indicates a benign neoplasm (pap-

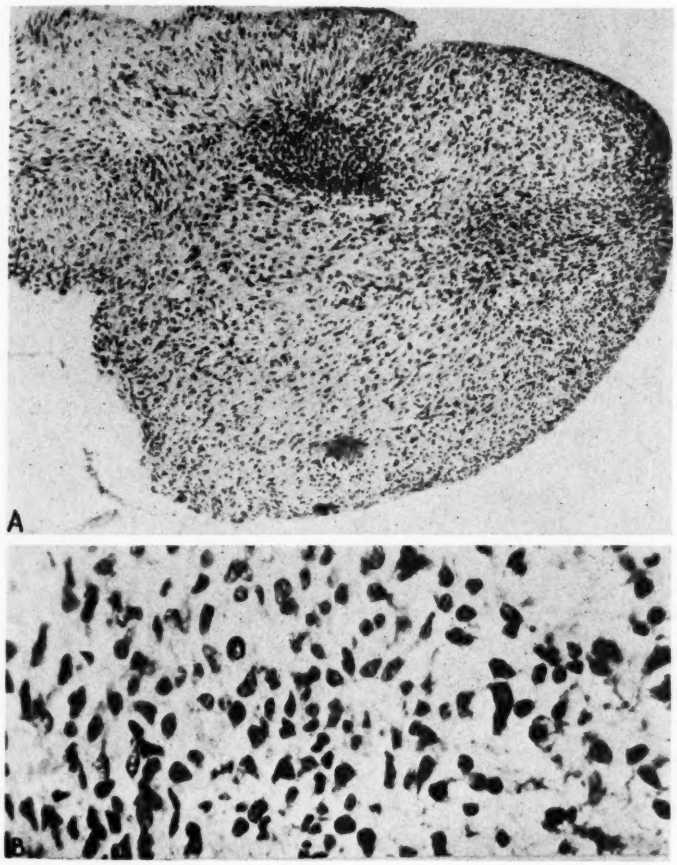

Fig. 2. Toe of a human embryo at the age of about two and one-half months.
A. Longitudinal section, with base of toe to the left. The cells destined to form fat, fascia, muscle, cartilage, and bone are indistinguishable. × 100.
B. A higher magnification of the same. Note the similarity to certain types of sarcoma. × 480.

illoma) (Fig. 4-A); growth into the dermis or subcutaneous fat usually indicates a malignant neoplasm—epithelioma or carcinoma (Fig. 4-B). If the mucosal layer of the intestine grows into the lumen and forms pedunculated masses of glandular tissue, the lesion is usually benign (adenoma) (Fig. 5-A); if it grows into the submucous or muscular coats, it usually is malignant (carcinoma) (Fig. 5-B). One has to consider not only the fact of architectural derangement, but also its character in recognizing the neoplastic process and in distinguishing between the benign and the malignant.

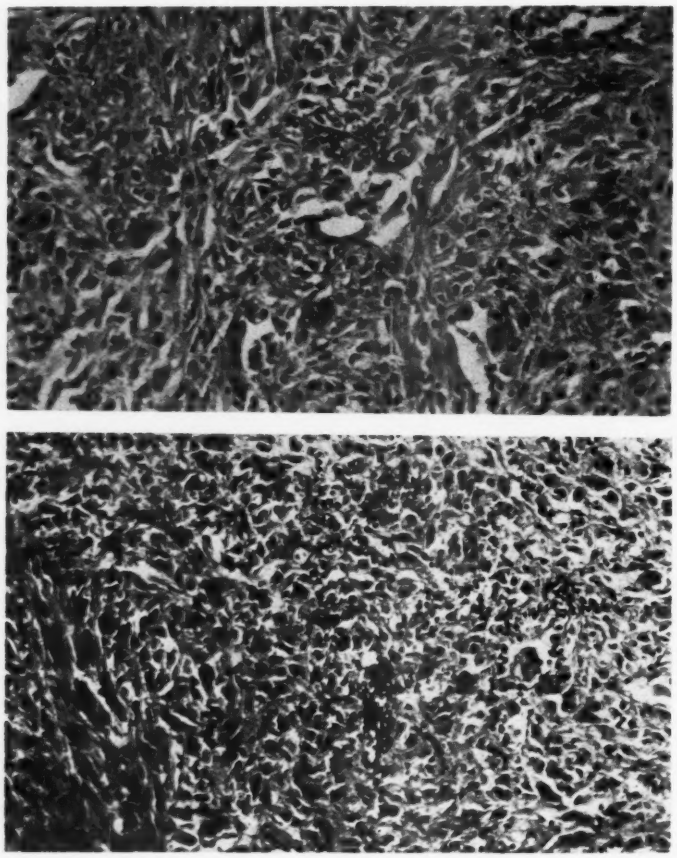

Fig. 3. A. Carcinoma of the lung. The patient was alive and well eight years after removal of the neoplasm.
B. Rhabdomyosarcoma of the diaphragm, discovered at autopsy. It is difficult to distinguish between the epithelial cells of one tumor and the mesothelial cells of the other. × 150.

Abnormalities of cellular details, especially when associated with architectural derangements usually are indicative of malignancy. These abnormalities include variations in the size of cells and nucleoplasmatic relationships, departures from the adult type and approach to the embryonal, abnormalities of nuclear chromatin and nucleoli, and abnormalities of mitotic and amitotic division. The presence of mitotic figures does not necessarily indicate malignancy, since they do occur in tissues that are not even neoplastic (Fig. 6). Their absence does not exclude malignancy. In general it may be said that the

greater the abnormality of the cellular detail, the more malignant the tumor is apt to be.

From the preceding discussion it is evident that the pathologist is largely concerned with those intrinsic manifestations by which he recognizes the fact of malignancy, identifies the origin and type of the neoplasm, and evaluates the degree or intensity of the malignancy.

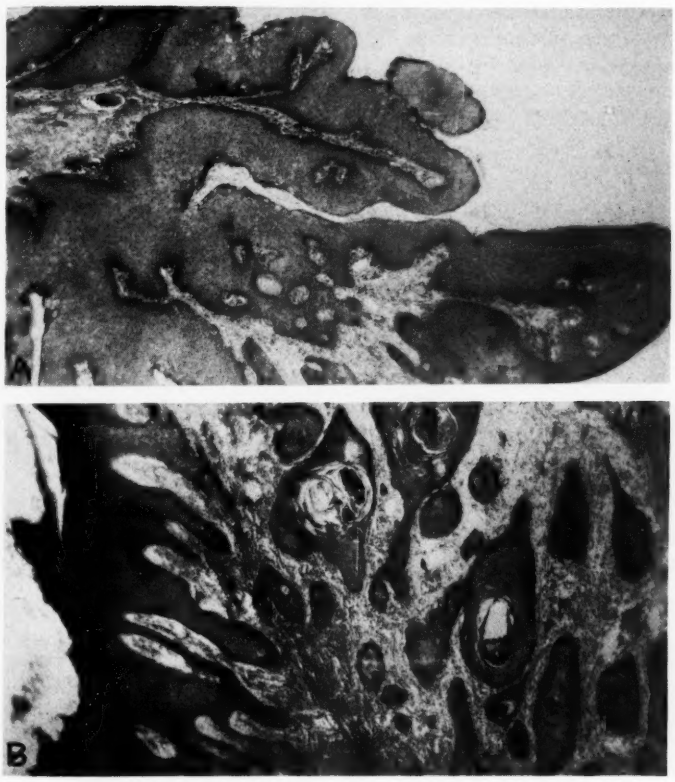

Fig. 4. A. Benign papilloma of the skin. The epithelial cells grow outward and do not invade the stroma.
B. Squamous-cell carcinoma. The epithelial cells grow inward and invade the dermis.

Histologic Grading: The histologic grading of neoplasms is almost exclusively the responsibility of the pathologist. The purpose of the grading is to express in convenient quantitative form the relative degrees or intensities of malignancy. The histologic and cytologic abnormalities, previously mentioned, constitute the principal basis for the grading. In any particular neoplasm some of these abnormalities may point toward high-grade malignancy, while others may be equally indicative of low-grade malignancy. Grading is an attempt to express an average of these indications.

As conceived and propounded by Broders, histologic grading is legitimate, desirable, and useful in many respects. In the hands of experts the gradations can be differentiated with reasonable uniformity and will reflect the intensity of the malignancy with reasonable reliability. This is in conformity with the observed fact that one type of neoplasm may be more "violently" malignant than another type, and also with the fact that a particular type of

neoplasm in a particular organ may be more "violently" malignant in one host than in another host.

In so far as histologic grading may be found useful in expressing these general relationships, it is excellent practice. It is particularly helpful to radiologists because it has been observed that the farther a neoplasm departs from maturity as a tissue, the higher its grade of malignancy becomes, and its sensitivity to irradiation is proportional to its immaturity. Conversely, the more nearly a neoplasm approaches maturity as a tissue, the less radiosensitive it becomes.

It should not be forgotten that the intensity of malignancy of a neoplasm, as expressed in terms of histologic grading, is not necessarily static. What is thought of as the grade of a neoplasm usually reflects its state at a particular moment. It may be questionable whether a neoplasm can change from high-grade to low-grade malignancy, but there is no question that the reverse can occur (Fig. 7).

It is equally important to remember that the use of the term "histologic grading" is legitimate and acceptable only when the recognition of the various grades is based upon histologic methods and is not dependent upon such accidental factors as invasion, metastasis, invalidism, or death, because it must be applicable in the absence of all of these manifestations of malignancy.

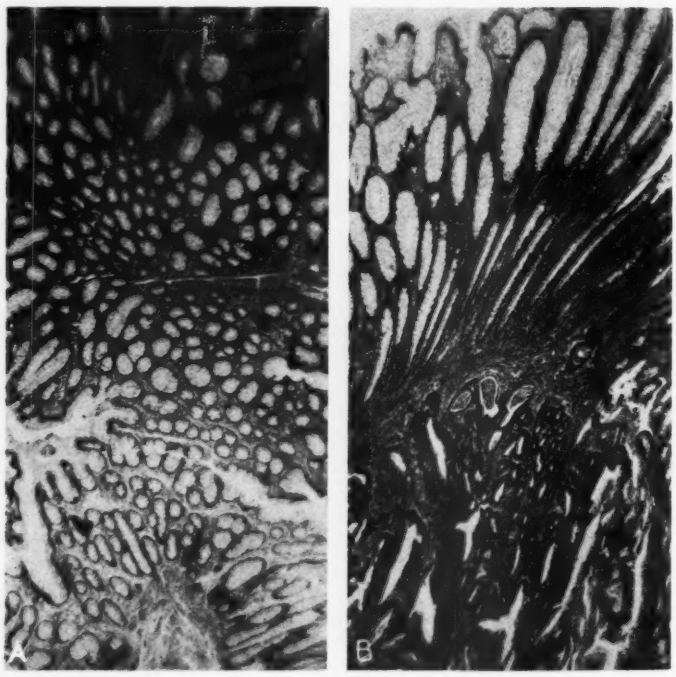

Fig. 5. A. Benign adenoma of the intestine. Polypoid masses of glandular epithelium project into the lumen but do not invade the stroma.
B. Adenocarcinoma of the intestine. Masses of glandular tissue infiltrate the submucosa.

With the foregoing reservations, histologic grading may be acceptable as the most convenient means of expressing the *inherent malignancy* of a neoplasm, especially in cases which run their natural course. The inherent malignancy of a neoplasm, however, should not be confused with the effects of the neoplasm upon the host.

INHERENT MALIGNANCY IN RELATION TO CLINICAL MANIFESTATIONS

In contrast to all of those qualities or phenomena which are innate characteristics of and are confined to the neoplasm, which can be discovered only as a result of a study of the neoplasm itself, there is the great variety of extrinsic manifestations which come about as natural consequences of having a neoplasm.

The extrinsic manifestations or effects of the neoplasm may be of a local, regional, or general nature. Some of these effects may be more or less directly related to malignancy as such, and hence may have value as criteria. Other effects may be more appropriately considered as complications, less directly related to malignancy as such, and hence not so reliable as criteria.

In order to distinguish more clearly between the intrinsic and the extrinsic manifestations of malignancy, it may be well to consider briefly some aspects of the behavior of neoplasms and some of the accidental factors which may modify their natural course.

The Neoplasm Itself: A neoplasm, in and of itself, produces no symptoms other than the mass. An exception is to be noted in the case of certain tumors of endocrine organs which may produce excessive quantities of hormones and thereby disturb the general economy. In such cases the symptoms are those of the excessive hormonal secretion rather than of the tumor *per se* and hence are not characteristic of the neoplastic state.

Neoplasms are not painful. They may become painful by irritation of, by pressure on, or by infiltration into nerves. They may become painful as a result of various sorts of disturbances of their blood supply, such as thrombosis, infarction, and hemorrhagic infiltration. Neoplasms may become ulcerated, infected, or undergo necrosis and in this way may indirectly cause symptoms of septic or proteolytic intoxication. A neoplasm, by reason of its location, may obstruct an excretory duct or hollow viscus and thus indirectly cause symptoms, depending upon the duct or viscus obstructed.

In so far as they pertain to the local mass, the so-called symptoms are really those of its complications and sequelae, and not those of the neoplasm itself. Whatever may be said of malignant neoplasms in these respects is equally applicable to benign neoplasms and hence cannot be considered characteristic of malignancy. It is true, however, that malignant neoplasms have a greater tendency to complications than do benign neoplasms.

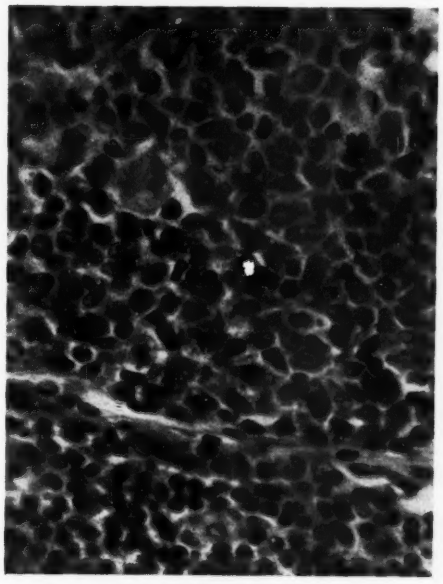

Fig. 6. A hyperplastic lymphoid follicle in an appendix, with many mitotic figures in the field. Mitosis is evidence of growth but is not necessarily an indication of neoplasia. × 500.

Local Infiltration and Destruction: Neoplastic infiltration of adjacent tissues or organs is a very important manifestation of malignancy from both pathological and clinical standpoints. As a criterion of malignancy it is valuable only when present. Its absence does not necessarily exclude malignancy. The symptoms provoked by the infiltration are determined largely by the location and extent of involvement. The effects may be attributed to the neoplasm directly, but indirectly

there may be equally important effects upon vital structures or functions.

Destruction of tissues, parts, or organs results primarily from impairment of nutrition, very largely through interference with blood supply. It may be caused by the neoplasm, but is not an infallible criterion of malignancy. An aneurysm can destroy several vertebrae as effectively as can a malignant tumor.

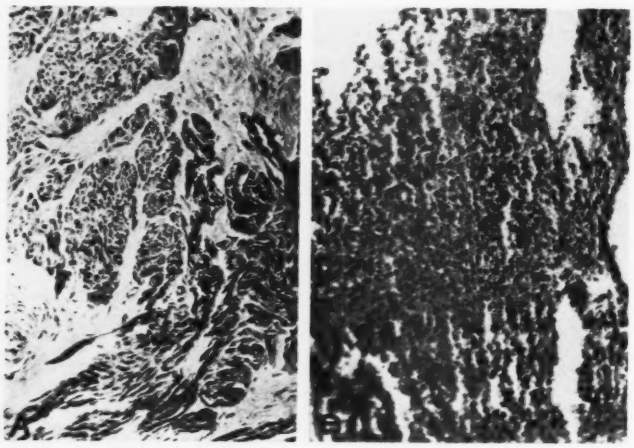

Fig. 7. Sarcoma of the crest of the ilium.
A. The primary tumor was a fairly well differentiated fibrosarcoma. × 80.
B. Two years later the intra-abdominal metastases were of a more highly malignant type histologically. × 120.

Dissemination of the Neoplasm: Perhaps the most unequivocal manifestation of malignancy is the natural tendency of certain neoplasms to establish secondary growths remote from the primary site, usually by transportation of viable particles through the blood or lymph stream. Like other manifestations, it is a valuable criterion of malignancy only when present. Comparatively rare though they may be, it is undoubtedly true that under certain circumstances metastasis is the final criterion required to establish the fact of malignancy, notably so in the case of certain neoplasms of the thyroid gland. Practically all of the generally utilized histologic and cytologic criteria may be absent in such a case (Fig. 8), including local invasion of surrounding structures. For this reason it becomes necessary at times to adopt special criteria which experience has shown to be applicable to thyroid neoplasms, even though they may not be required for tumors elsewhere.

The effects of the secondary or metastatic growths upon the host closely approximate those of a comparable primary neoplasm developing at the site, so far as one individual nodule is concerned. Secondary growths, however, are prone to be multiple and may involve many parts simultaneously or successively. Hence, the results of metastasis may be much more complicated than the results of a primary growth.

Ultimate Effect upon the Host: The natural tendency of a malignant neoplasm is to progress and finally to cause the death of the host. The rapidity of progress, the complications, the symptomatology, the degree of invalidism, and the duration of life before death terminates the picture, are extremely variable even for a particular type of neoplasm in cases which are allowed to run their natural course.

The extreme variability in the clinical manifestations, in the character and intensity of the harmful effects upon any part or

the entirety of the host, and in the period of survival with cancer, clearly indicates that there is no specific cause-and-effect relationship between the inherent malignancy of the neoplasm and what by common consent are considered to be its clinical manifestations. It clearly indicates that there is no specific noxious agent, and no specific mechanism upon which such an agent could operate to bring about such a varied set of clinical manifestations.

The alternative is that the clinical manifestations are the direct results of the complications induced by the accidental circumstances of location of the primary neoplasm, the distribution of secondary deposits, and the opportunities which may arise for interference with important and vital functions. The malignancy of the neoplasm may be thought of in terms of its potentialities for bringing about such complications.

Death is the climactic episode which terminates the natural course of cancer, but it is not due to the mere fact of having cancer. The causes of death of persons who have cancer are the same as the causes of death of those who do not have cancer, namely, the failure of vital functions such as the respiratory, the circulatory, the nutritional, the neuro-regulatory, and others. These functions can be impaired or suppressed by a non-neoplastic process or by a benign neoplasm quite as effectively as by a malignant neoplasm. Hence, death is no more a criterion of malignancy than it is a criterion of a non-neoplastic process or a benign neoplasm.

CURABILITY OF THE NEOPLASM

Since malignant neoplasms cannot be prevented, since there is no specific "cure" available, and since neoplasms exert their malign influence by reason of their natural tendency to spread to points beyond their site of origin, it is obvious that the possibility of cure is limited to that period of time during which there is a local growth. It is undoubtedly true that many different types of neoplasms, even of high-grade malignancy, occurring in many different sites, may be cured. The means by which this desirable objective is attained are those of destruction or eradication while the tumor is still a local growth. It is equally true that any type of neoplasm, even of low-grade malignancy, may be incurable if it spreads beyond the sites

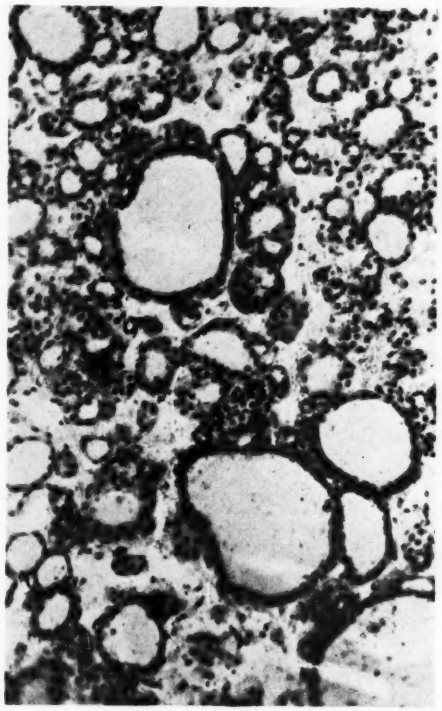

Fig. 8. Thyroid metastasis in the clavicle, having the histologic and cytologic characteristics of an adenoma and not those of a carcinoma. There was no local invasion through the capsule of the primary adenoma in the thyroid. Death occurred five and one-half years after the primary operation. Such neoplasms require the acceptance of special criteria to supplement the histologic criteria of malignancy. × 120.

in which the principle of eradication or destruction is applicable (Fig. 9). A particular type of neoplasm, of a certain inherent malignancy (Grade II), may be curable in one organ because it is accessible and can be destroyed or eradicated, while a similar neoplasm in another organ cannot be cured because it is not accessible or because its destruction or eradication would suppress or impair the important function of the

organ. Hence, the duration of a neoplasm, which is conducive to dissemination, its location, which admits of or prevents the application of the principle of destruction or eradication, and the danger of suppression or impairment of vital functions are important considerations in curability, irrespective of type or histologic grade.

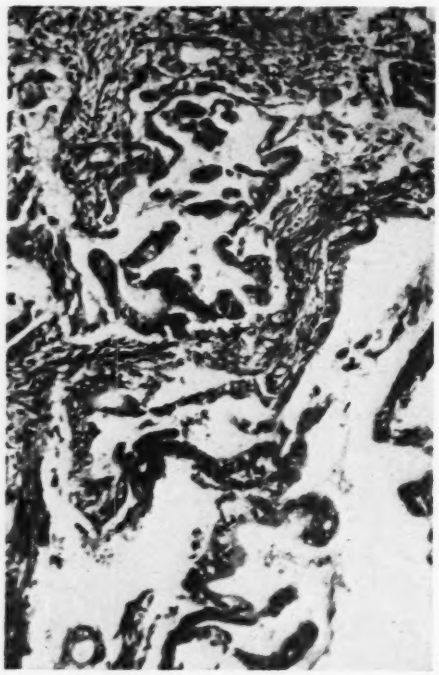

Fig. 9. Carcinoma of the pancreas, highly differentiated and of low-grade malignancy. Surgical removal did not result in a cure because of inaccessibility and inability to completely eradicate the neoplasm locally. × 120.

A clear distinction should be made between the inherent malignancy of a neoplasm and its curability. These are two entirely different matters and are conditioned upon entirely different circumstances. A Grade IV carcinoma (Fig. 10-A), if accessible and adequately treated early, is just as curable as a Grade II carcinoma. A Grade II carcinoma (Fig. 10-B), if treated late, is just as incurable as a Grade IV carcinoma. In untreated cases the difference is in the more rapid progress to a fatal termination in the Grade IV carcinoma.

CLINICAL APPLICABILITY

In the preceding discussion we have considered the criteria by which a neoplasm may be recognized as malignant, its complications, its local and general manifestations, the manner in which these phenomena are brought about, and the effects upon the host, and have indicated a distinction between the malignancy of the neoplasm and its curability. The following examples may serve to illustrate the interplay of some of these various factors, and their influence upon the natural outcome of malignant neoplasms, with particular reference to longevity.

A small carcinoma of Grade II malignancy, situated in the head of the pancreas, may obstruct the common duct, cause jaundice, and terminate more rapidly than a larger carcinoma of Grade IV malignancy situated in the tail of the pancreas. In this instance it is the *location* rather than the size or the inherent malignancy of the neoplasm which shortens life.

A carcinoma of the intestinal tract, if it causes intestinal obstruction, shortens life more than does an exactly comparable tumor which does not cause obstruction.

Neoplasms of the bladder and prostate which interfere with the functions of the urinary tract have a more decided influence upon the years of survival than do comparable tumors in the genital tract which do not interfere with urinary function.

Intrathoracic neoplasms shorten life more than exactly comparable neoplasms in other locations because in the thorax there is greater opportunity for interference with vital functions, or because of greater danger of complications.

Intracranial neoplasms, by interfering with the vital function of respiration, may shorten life more than do neoplasms which do not interfere with this function.

A carcinoma of the breast in one person may metastasize to the axillary lymph nodes and bones, and be not inconsistent with a survival of ten years or more. In another person an exactly comparable neoplasm may metastasize to the lungs and thence to the brain, causing death within a

few months or a year. In these instances it is the distribution rather than the fact of metastasis which determines the difference in the clinical course.

Sarcomas, as a rule, run a more rapidly fatal course than do carcinomas. In general sarcomas metastasize through the blood stream, notably to the lungs, while carcinomas metastasize through the lymphatics, primarily to regional lymph nodes. In these instances, apart from the difference in the type of growth, it is the *mode of dissemination* rather than the *fact of dissemination* which determines the difference in clinical course. Likewise, it is the *distribution* rather than the *fact of metastasis* which materially affects longevity.

A carcinoma of the breast, irrespective of its inherent malignancy (histologic grade), does not cause death so long as it is limited to the breast. Even though it infiltrates the pectoral muscles and metastasizes to the lower axillary lymph nodes, it does not affect health or shorten life, so long as it is limited to these areas. But if the same tumor metastasizes to the bones, intrathoracic lymph nodes, liver, lungs, or brain, it very materially affects health and shortens life, but not necessarily to the same extent in the several instances.

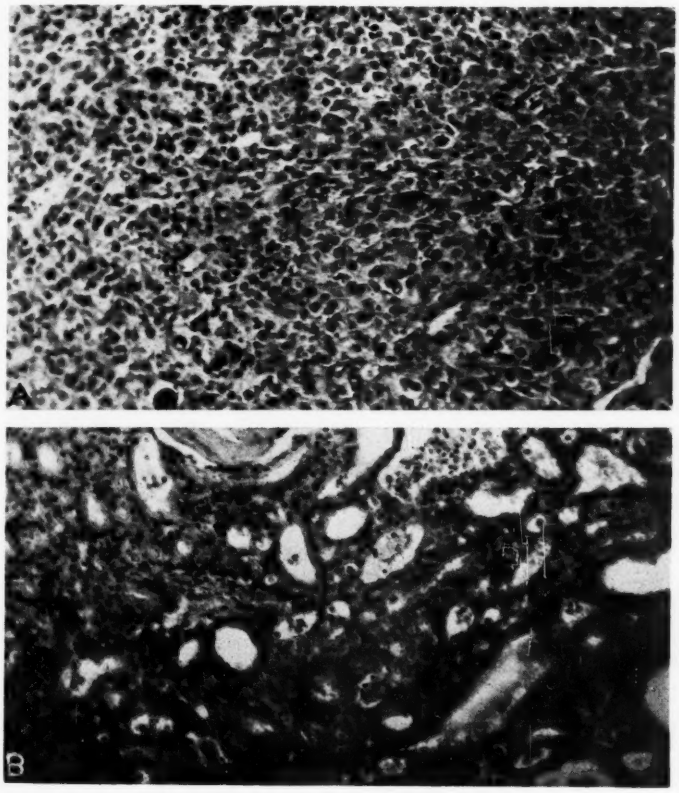

Fig. 10. Carcinoma of the breast.

A. Histologically, a highly malignant (Grade IV) neoplasm. The patient was operated upon early and was well seven years later. Irradiation was not employed.

B. A highly differentiated carcinoma of low-grade (II) malignancy. The patient was operated upon late, received roentgen and radium treatment, and was not cured. The histologic grade is not the determining factor in the curability of neoplasms. × 120.

TREATMENT

The very fact that treatment is instituted shows an intention of modifying the natural course of a malignant neoplasm. How successful the treatment may be in the attainment of its objective, which is cure, is dependent upon the circumstances which obtain in the individual case treated. This applies not to any particular circumstance, or to any set of circumstances, but to all of the circumstances taken together, including the circumstances of the treatment itself.

Since we are concerned here with the principles of treatment rather than with technical details, the basic principle for the cure of a malignant neoplasm may be stated succinctly as follows: *The neoplasm must be completely extirpated or completely destroyed while it is still a local growth or before it has extended beyond the sites in which it can be completely extirpated or destroyed.* The attainment of the objective (cure) is more important than the means by which it is accomplished.

The requirements of the foregoing principle impose upon surgical treatment the definite limitation of the anatomical possibility of the removal of tissue. The location of the neoplasm, its accessibility, and the necessity of not interfering with important functions, may be included under the anatomical limitations. Within these limitations the surgeon is certainly and legitimately in his sphere. While he remains within the legitimate sphere of surgical treatment, the inherent malignancy of the neoplasm is of less importance than is the fact of its localization to a removable site.

The foregoing principle imposes upon irradiation treatment the necessity of delivering to the neoplasm a lethal dose of energy. The radiologist is very greatly concerned with the inherent malignancy or histologic grade of the neoplasm because it is the best index of radiosensitivity, which in turn determines to a considerable extent the response to a standard dose of radiation.

Whether the treatment be carried out by the surgeon, by the radiologist, or by both, the prime requisite is that the eradication or the destruction be complete. Five per cent, or even less, of a cancer can cause death whether left by the surgeon or by the radiologist. Moreover, the best time to cure a cancer is at the time of the first attempt. Repeated attempts generally are less successful. Cancers do not become more curable by delay. Delay is conducive to dissemination. Dissemination is the greatest obstacle to cure by present methods of treatment.

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DISCUSSION

M. C. Sosman, M.D. (Boston, Mass.): I should like to ask Dr. Graham how he decides whether or not a tumor is radiosensitive.

Allen Graham, M.D.: It is generally accepted that a highly differentiated tumor is more radiosensitive than one which is not so highly differentiated. The differentiation of tumors is conveniently expressed in terms of histologic grading. The grading of tumors should not be confused with prognosis. There is certain to be a considerable error when histologic grading is made the basis for predicting how long a patient may live. The duration of life is more intimately related to numerous incidental and accidental circumstances of the tumor than it is to the histologic grade of the tumor.

R. R. Newell, M.D. (San Francisco, Calif.): Among Dr. Graham's pictures was a section of carcinoma of the lung. I should like to ask how, with the section shown, he knows that is a carcinoma.

Allen Graham, M.D. (*closing*): For the interpretation of the nature of a neoplasm one requires all of the information possible to obtain. It is difficult enough, in many instances, even under the best of circumstances to diagnose and classify and estimate the malignancy of a neoplasm even though one has considerable material or data to go on. In the case under discussion we had the location and the gross tumor to examine. It was entirely confined within the lung and was removed as a local growth. The tumor cells had the histology of epithelial cells. On the basis of these facts we assumed that the tumor was a carcinoma of the lung, and believe the assumption reasonable.

There are certain tumors involving the lung, particularly certain tumors involving the pleura, the nature of which will be subject to differences of opinion among expert pathologists, which means that there is a limitation to the histologic interpretation of the nature of certain tumors. Conclusions are based upon the weight of evidence and are subject to error.

Tumors of the Adrenal and the Use of Air Insufflation in Their Diagnosis[1]

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TUMORS OF THE adrenal are rare. The opportunity has fallen to few to study personally even a small number of these tumors. From among a large series of patients presenting symptoms suggestive of adrenal neoplasms, we have been able to show, at least to ourselves, that tumor could be proved to be the cause of the symptoms in relatively few cases. When tumor does occur, it is now accepted as to be without doubt the causative factor of the symptoms. Symptoms, when they occur, can be separated into different clinical pictures according to the sex of the patient and the type of tumor. This presentation will report the clinical classification of these tumors, with a discussion upon the diagnosis of their presence by perirenal insufflation roentgenograms.

The normal adrenal may be visualized in certain persons by ordinary roentgenograms. In most cases, because of the position of the glands and low density of the adrenal tissue, their shadows are not clearly seen. Pathological adrenals may produce a deeper shadow if their tissues have increased density. Some tumors of the adrenal because of an increase in density may form an interpretive shadow upon a film. If a tumor is large, it may displace some other shadow-producing organ, as the kidney, and thus suggest its presence. If very large, it may be palpated and the probable diagnosis arrived at by the use of contrast media to identify adjacent organs upon the films; from their apparently normal shadows which are displaced by the tumor, the diagnosis may be suspected by exclusion.

As a diagnostic aid in suspected adrenal pathology we have introduced a gas (air) into the perirenal fascial planes to visualize them better and to outline the adrenal and kidneys. The procedure was first described by Carelli in 1921 (1). It has been used by us in several hundred cases since 1930. The normal adrenals are usually well visualized if sufficient air is introduced in the proper plane. They are better visualized in thin people. The right adrenal more frequently shows as a long thin wedge and the left as a wider, shorter wedge or crescent. When tumor is present it, also, is more clearly shown in thin people. It is rounder when small, ovoid when larger, and rounded or lobulated when very large. In our series when a tumor was diagnosed by shadow interpretation it was confirmed by operation and by removal. In a number of cases in which no tumor was shown, its absence was confirmed by operation and adrenal resection, both performed in a hope of symptomatic improvement. In several cases in which it was impossible from the films to determine whether or not tumor was present, operation showed no tumor, leading to the opinion that the method was of value in establishing the presence of a neoplasm. Its especial value is to determine if tumor is present in those cases in which a neoplasm is unrecognizable by any other method, is of early origin, and small enough to offer hope of a cure if removed. For these purposes the technic has been reported by the writer and others, in each instance with individual modifications, but all producing the same end, air around the adrenal and renal fascial planes and resultant changes in the roentgenographic film (2, 3, 4, 5, 6, 7, 8).

The method carefully used and with

[1] From the J. Bentley Squier Urological Clinic, Columbia-Presbyterian Medical Center, New York. Presented before the Radiological Society of North America at the Twenty-sixth Annual Meeting, Cleveland, Ohio, Dec. 2–6, 1940.

proper technic is not hazardous when applied for the purposes mentioned. With large tumors, palpable and recognizable as tumor, and with infiltrating tumors of the renal area with a great increase in the vascular network of that area, the hazard is increased as far as the possibility of air embolus is concerned. For such cases the method may not offer any advantages over other types of diagnostic procedure, such as secretory or retrograde pyelography. Certainly with the presence of a tumor already established and an obvious syndrome of adrenal disturbance, it may be of only little further aid in diagnosis, possibly in determining tumor infiltration into surrounding tissues where there is failure to show an infiltration of air upon the films. Of interest is the fact that with this procedure only one adrenal could be shown to be present in 8 per cent of the several hundred cases examined. In our personal experience in insufflating air over 400 times, there have been no hematomas, no infections, and no air emboli.

The mammalian adrenal is actually two glands fused together in development, each with an essentially different origin, different type of tissue, and different function but enclosed in an enveloping capsule and with tissue stroma. Thus when tumors arise in the adrenal they can be basically classified as follows:

A. Those arising from the various layers of connective tissue, blood-vessels, lymphatics, or nerve tissue within the glands. These are similar to tumors arising from the same structures in any other gland. Among these have been reported fibroma, neurofibroma, myoma, osteoma, hemangioma, lymphangioma, and melanoma. Such tumors are not peculiar to the adrenal and are very rare in that organ.

B. Among tumors peculiar to the adrenal are those arising from the cortex. Because of its origin and cellular glandular tissue these are mesodermal glandular growths.

C. The other type of tumor peculiar to the adrenal is that arising from the medulla. Because of the origin of the medulla these are ectodermal sympathetic nerve system tumors, either of the nerve secreting cell or of the nerve fibril cell.

Since both the cortex and the medulla are hormonal glands, and each contains cells which are actively secreting hormonal substances, in addition to other cells in the process of growth to secreting cells or of degeneration after exhaustion of their secretion, and still other apparently non-hormonal cells peculiar to the adrenal, tumors occur in both cortex and medulla, the cells of which may either be hormone-producing or non-hormone-producing. The hormones of the cortical cells have been only partially identified. The only known hormone identified with the medulla is epinephrine or adrenalin. When tumors of the cortex occur, it has been shown by a number of investigators that the hormone or hormones produced by the tumors are often in excess of those normally present (Levy Simpson, de Fremery, and Macbeth, 9; Gallagher, 10; Callow, 11; etc.). It has also been shown that abnormal or perverted hormones may occur with some of these tumors (Butler and Marrian, 12). This excess of normal or perverted hormones produces clinical syndromes which suggest the presence of the tumor; the type of symptoms and changes in the individual will vary according to the amount of the hormone present and its influence upon tissues susceptible to its action. As yet it is not known whether in the adrenal cortex specific cells produce specific hormones or not, or whether if there are various hormones they are elaborated by one cell. The cortical hormones have been shown to be sterols. The only known secretion of the medulla is epinephrine and the only known hormonal change with medullary tumors has been an increase in the amount of epinephrine in the blood stream with its resulting symptoms.

Air insufflation can be better evaluated if its use and correlation are discussed with each type in the clinical classification of adrenal tumors which we have found to be of most value. This classification

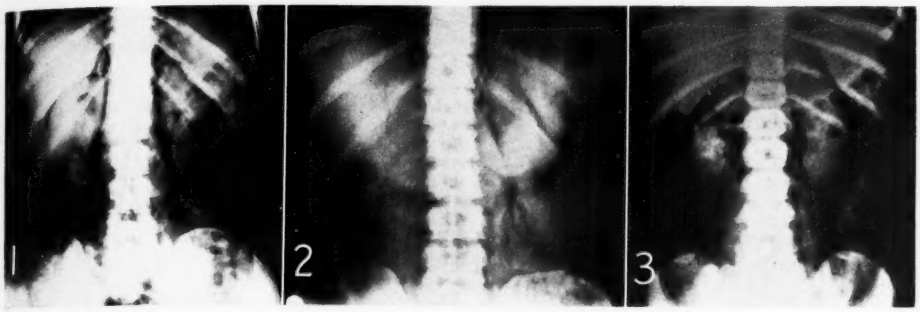


Fig. 1. Film showing air insufflation around the adrenals and kidneys in a young woman with virilism. This has been considered to show the appearance of a normal right adrenal. The left adrenal is more dimly shown due to the fact that it is thin and flat.

Fig. 2. Film showing air insufflation around left kidney and adrenal tumor in a patient without hormonal changes. The kidney is below, and the tumor is the large round shadow superimposed anteriorly over the upper half of the kidney. This tumor arose from the lower portion of the adrenal; the upper portion is represented by the thin narrow shadow between the vertebral column and the inner upper border of the tumor. This portion of the adrenal was normal.

Fig. 3. Air insufflation film of a female child, three years of age, with male pseudohermaphroditism. Both adrenals are larger in proportion to the kidneys than in the adult. Both are of normal shape and give no roentgenographic evidence of tumor.

we have formed from our own cases and from those reported by others from the literature.

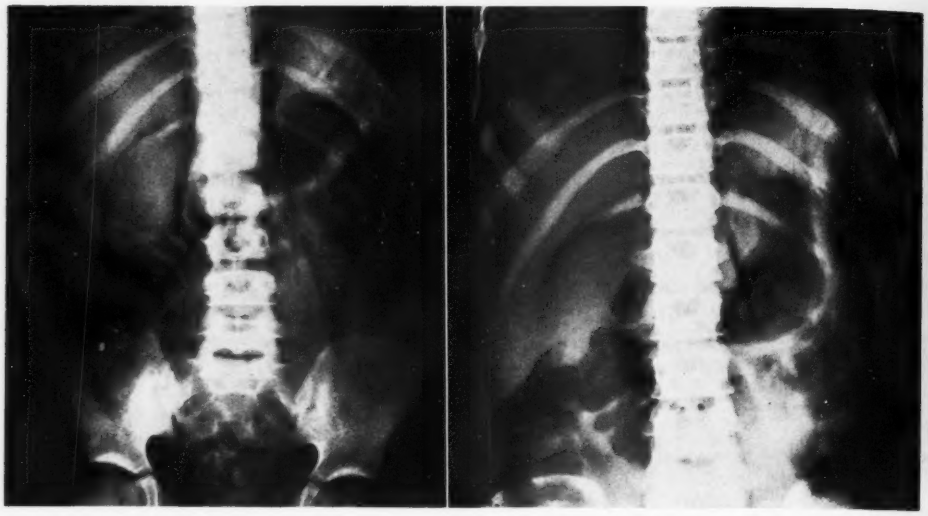
CORTICAL TUMORS

Cortical tumors may be grouped as follows:

1. No recognizable hormonal changes.
   (*a*) Adenoma
   (*b*) Carcinoma
2. Tumors with hormonal changes.
   (*a*) In the female toward masculinity (androgenic).
   (*b*) In the immature male toward maturity (androgenic).
   (*c*) In the male toward femininity (estrogenic).
   (*d*) A sex change combined with other metabolic changes.
   (*e*) Metabolic changes (without sexual changes) in the skin, fat deposits, plasma, blood, sugar metabolism, and psychic or emotional changes. (Cushing's syndrome.)

1. Tumors with No Recognizable Hormonal Changes: In this group are included those rare tumors which arise from the connective tissue and other tissues within the adrenal and which are not peculiar to it. These vary accordingly in symptoms whether small or large, benign or malignant. If small and benign, they are discovered only by accident. If malignant, they produce no particular symptoms except pain and the general manifestations of malignancy. In our department one benign cystic fibroma was disclosed by its shadow and by compression of the upper pole of the kidney as shown by pyelograms. Air insufflation was not used. The tumor was removed operatively. There have been no other examples of these rare tumors in our series, so that we have had no experience with the shadows that would be produced by air insufflation.

(*a*) Cortical adenomas are mostly asymptomatic and are found accidentally at autopsy. Geschickter (13) reported 63 cases so discovered and without symptoms. The tumors are small, the size of a seed or pea, and are benign. From our studies of over 500 adrenals outlined by air insufflation we have been unable to determine from the adrenal outlines whether or not a small adenoma was present. In 20 non-tumor adrenogenital syndrome cases among these, the adrenals were operatively exposed after air insufflation, and no adenomas were found on inspection or microscopic study. In an equal number no change in the adrenal could be felt by palpation of the gland in

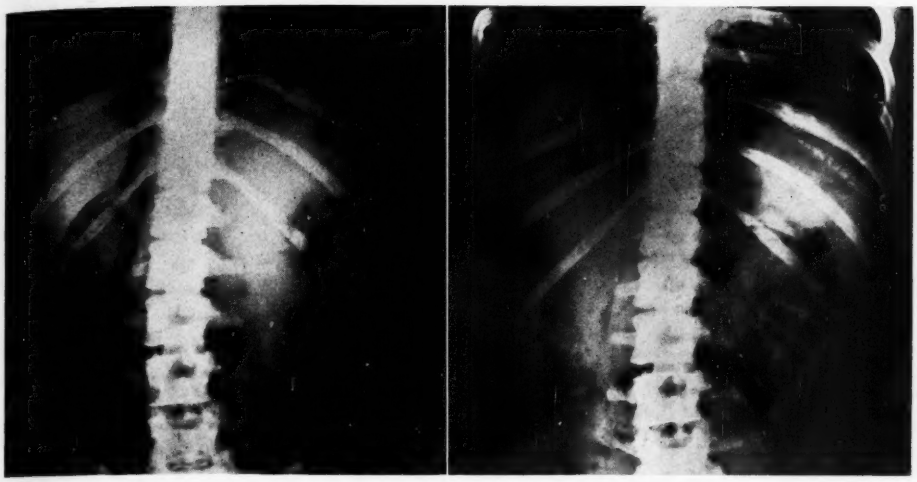


Figs. 4 and 5. Air insufflation films of a female child with male pseudohermaphroditism taken at four (left) and five (right) years of age. The adrenals are of normal shape and no roentgenographic evidence of tumor is present.

the course of abdominal exploration. Judging from these efforts, air insufflation does not seem to be able to produce shadows by which these small changes in the adrenal may be visualized.

(*b*) Carcinomas of the adrenal cortex arising from non-hormonal cells have produced mostly the symptoms of pain in the side affected, weakness, fatigue, and lassitude. The symptoms have usually been present for a considerable period before a diagnosis has been made, and are often associated with a palpable mass in the abdomen. These tumors frequently displace the kidney downward, and may involve the structure of that organ. They are dense and produce a shadow above the displaced kidney. The displacement is clearly demonstrated by roentgenograms and particularly by pyelograms. The upper pole may be pushed downward and inward, forcing the hilum of the kidney downward. Rarely similar displacements on the left side may be caused by an enlarged spleen with retroperitoneal adhesions. At other times the adrenal tumor may arise from a portion of the adrenal and enlarge anterior to the kidney, as was clearly shown in one of our cases when we demonstrated the tumor by air insufflation. In this instance, the tumor was anterior to the kidney and did not displace it. These large carcinomas may be shown to be apart from the kidney by the presence of air between the kidney and the tumor on the films. In one very large nodular palpable tumor with renal displacement we did not attempt to delineate the tumor because we suspected marked vascular dilation in the perirenal tissues and wished to avoid a hematoma or the possibility of air embolus. Our suspicion was confirmed when the tumor was removed.

2. Tumors with Hormonal Changes: (*a*) In tumors occurring in the female in which the hormonal secretion causes a perversion of sex or change to masculine characteristics it has been shown that the excess hormone which is excreted in the urine is androsterone, the amount varying with the degree of masculinity. These tumors occur more frequently in the younger age group. In small female children they cause the syndrome of pseudohermaphroditism. In our cases the syndrome occurred much more frequently without demonstrable tumor. To de-



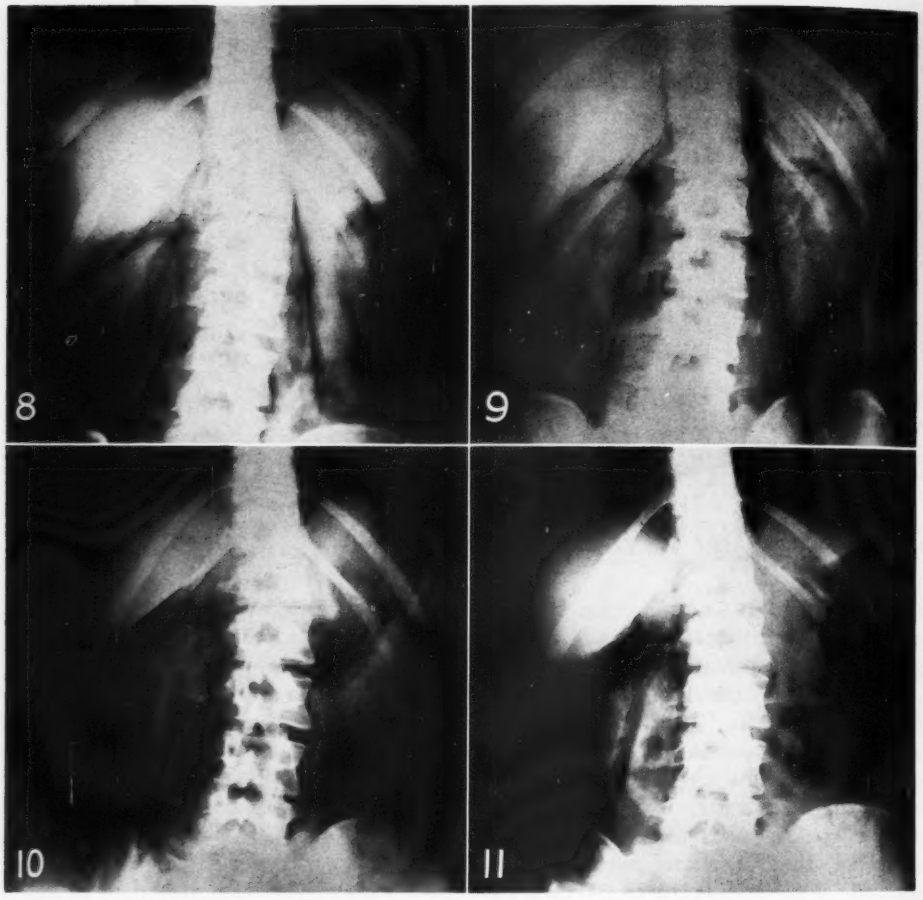
Figs. 6 and 7. Films of a female child aged eleven, with male pseudohermaphroditism. Fig. 6 (left) shows air insufflation around the right adrenal. This adrenal is large, of apparently normal shape, and no tumor appears to be present. Fig. 7 (right) shows air around the left adrenal. This is also large but does not appear to contain a tumor.

termine whether or not a tumor was present we used air insufflation in all cases. The amount of air varied with the size of the child. From 150 to 250 c.c. were used upon each side. The air is injected easily and with practically no pressure. It diffuses well and outlines the planes clearly. Often, because of an absence of fatty capsule around the upper pole of the adrenal, that part was not well outlined. The adrenal in infants and children is relatively larger than in adults, and the usual shape will more often persist even though the gland is much larger than normal.

In female children beyond puberty and in young female adults the syndrome of female virilism was the most frequent among those in whom adrenal pathology was suspected. Tumor is not common as an etiologic factor but, when it is present, is the cause of the virilism. For differential diagnosis we have used air injections in all cases. These patients with their masculine physique and non-femininity allowed the procedure to be done without objections or complaints. Roughly 300 c.c. of air produced the clearest illumination of the fascial planes. Since there is only a small amount of fat in these cases, the air clearly and completely outlines the adrenals and the tumor, if such is present. It is in this group that small tumors may be delineated early, diagnosed, and removed before the hormonal influence fixes the hair growth on the face and closes the epiphyses. These tumors apparently very early show an ovoid shape in comparison with the normal wedge-shaped shadow of the adrenal.

(*b*) In male children in whom the symptoms tend toward early adult masculinity the excess hormone has been shown, as in the female, to be androsterone. The majority of children with this syndrome, described as macrogenitostomia praecox, do not have an adrenal tumor as the cause, but when tumor does occur, it again is definitely the causative agent of the syndrome. For the differential diagnosis between tumor and non-tumor we have used air injections. These children because of their precociousness are somewhat difficult to inject. The amount of air used and the diffusion are similar to that in small females.

In these younger female and male tumor patients in whom the hormone produced is one with androgenic activity,



Figs. 8–11. Films of a young woman of eighteen with male characteristics present for six months. Fig. 8 was taken after air was injected on both sides. The air has infiltrated around the right kidney and adrenal. This adrenal appears normal. The air has not as yet infiltrated around the left adrenal.

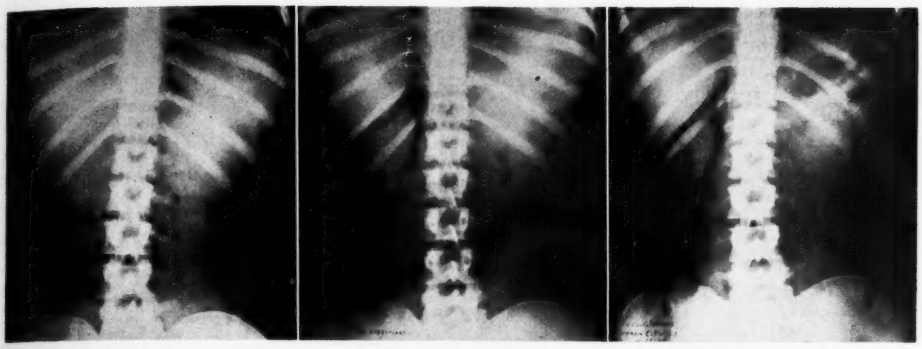
Fig. 9, taken twenty-four hours later than Fig. 8, shows the air infiltrating around an ovoid left adrenal tumor. This arose from the outer portion of the adrenal. The normal inner portion may be seen between the vertebral column and the tumor with which it blends.

Fig. 10, taken six months later, shows an increase in the size of the lower portion of the remaining right adrenal, the tumor on the left having been removed.

Fig. 11, taken one year later, shows a still further increase in size of the lower portion of the right adrenal, apparently due to a tumor growing in this portion.

there apparently does not seem to be any depression of the function of the normal life maintenance substance or hormones of the opposite adrenal. According to our air-insufflation roentgenograms the opposite adrenal was apparently normal anatomically and proved to be functionally capable of carrying on life after removal of the tumor-bearing adrenal. Subsequent air studies upon the unoperated side in two of our cases several months later showed an increase in size of the remaining adrenal.

(*c*) Changes in the male toward femininity have been rare with adrenal tumors. Cases have been reported by Holl (14), Lisser (15), Burrows, *et al.* (16), and Levy Simpson and Joll (17). The nearest approach to this type in our series was a male with gradual diminution of the size of the genitals, loss of sexual desire and performance, increase in size of the breasts



Figs. 12–14. Films of a girl of sixteen with intense masculinization. Fig. 12 (left) shows air insufflated around the left kidney. The amount of air used was small, but it outlines the large pear-shaped tumor with a small teat-like projection in the adrenal notch. The kidney has been pushed down and is not visualized, but the edge of the spleen is clearly shown.

Fig. 13 (center), with air insufflated around the right adrenal, shows a small adrenal above the kidney shadow.

Fig. 14 (left), taken a month after operation, shows hypertrophy of the right adrenal after the opposite tumorous one was removed.

and buttocks, and a change in the type of hair. Burrows and Levy Simpson first showed that with these tumors there was a high estrogen hormone excretion in the urine. In our case air insufflation roentgenograms were easily obtained and the adrenals were well outlined. We were unable to obtain operative consent to determine whether or not the large left adrenal was neoplastic.

A number of cases of hypospadias with undescended testes were studied, with the diagnosis of male hermaphroditism. In order to investigate the possibility of adrenal influence upon this malformation air insufflation studies were done. The air was insufflated without difficulty and the adrenal shadows were clearly outlined. No adrenal changes were seen in any of these cases.

(*d*) Sex changes, as above described, combined with metabolic changes, were seen more frequently in the adult age group and constituted one of the more frequent types encountered. Some similar syndromes have been described under the term "Cushing's syndrome," following Cushing's description (18) of the changes associated with basophilic adenoma of the pituitary. Over 50 females with virilism associated with other metabolic changes were studied. The symptoms presented with more or less regularity were: obesity of the face, neck, and abdomen; some plethora with striae of abdomen and thighs; hypertrichosis; hypertension; low sugar tolerance; amenorrhea; dryness of the skin and acne.

The sex inversion changes in this group have been shown to be associated with excretion of excessive androgens in the urine, the amount varying with the degree of masculinity. The other metabolic changes apparently are due to the production of excessive amounts of cortical hormone or hormones and their effect upon the various organs. These substances have not as yet been completely identified.

The insufflation of air in these metabolic cases has been more difficult than in others because of the emotional instability of the patients and because the fatty deposits in the abdomen and flanks make it more difficult to determine the amount of air needed for adrenal visualization. As a rule, amounts up to 500 c.c. are necessary for good diffusion. The air in all diffuses poorly and often gives mottled shadows. A small tumor in our series gave a fairly good picture. Two larger tumors, both large active carcinomas of the right adrenal, were attached to the under surface of the liver and, since air did not diffuse through the attachment, were only outlined below. Frequently several exposures taken hours apart outlined different parts of the tumor

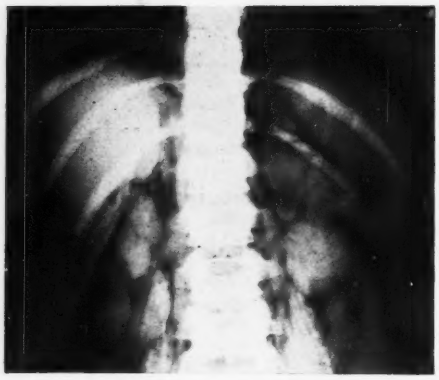


Fig. 15. A film with air insufflation around both adrenals in a boy of six with adult masculinity. The right adrenal looks small. The left looks larger than normal but is of normal shape. From the roentgenogram a diagnosis of tumor could not be made.

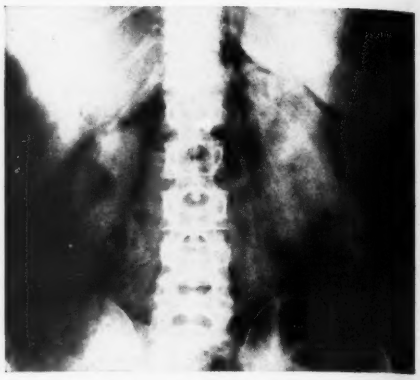


Fig. 17. Film of a woman of thirty-five with male characteristics and other metabolic changes similar to Cushing's syndrome. An ovoid tumor above the right kidney fills the adrenal notch, displacing the liver edge outward. The left adrenal appears as a small wedge on top of the kidney.

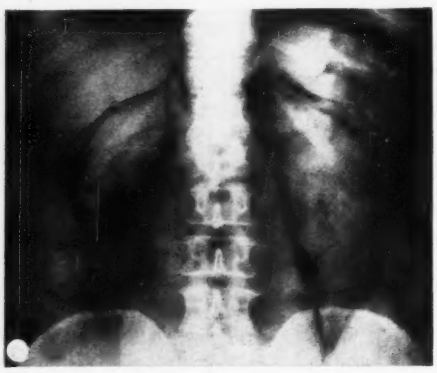


Fig. 16. Film of an adult male developing feminism. The air outlines the right adrenal fairly well but shows an unusually large irregular shaped gland on the left, suggesting tumor. Since the patient refused operation this shadow was not verified.

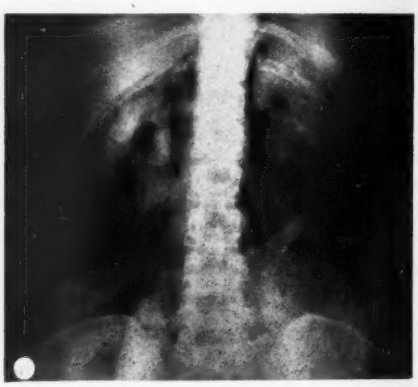
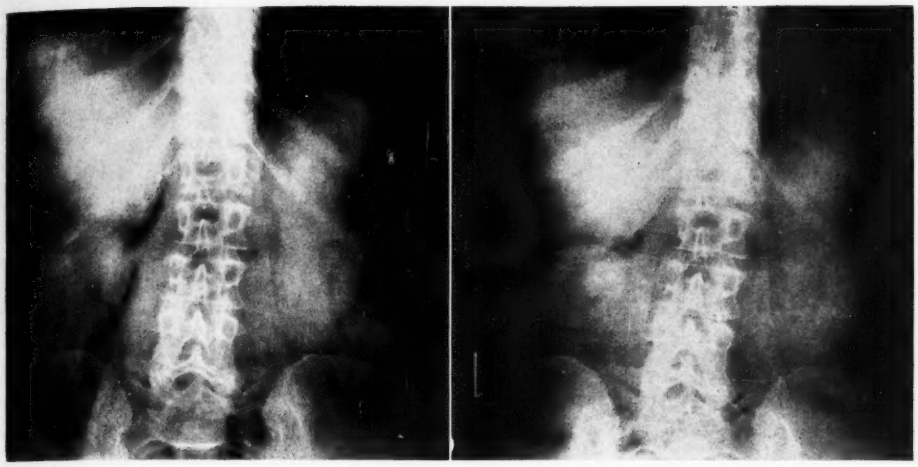


Fig. 18. Film of a female with only the metabolic changes suggestive of Cushing's syndrome. The air has infiltrated with a mottled effect, but the right adrenal is seen above and inside the upper pole of the kidney. The left adrenal is represented by the dense triangular shadow looking as if fused to the upper pole of the left kidney. Other films showed air separating the tumor from the kidney. Following removal of the tumor, the right adrenal, as outlined, was not functioning, and on autopsy was found to be atrophic.

as the air slowly infiltrated through the fascial planes, and a composite of the films was necessary to visualize its size and shape. Of particular interest were the shadows cast by the opposite supposedly normal adrenal. In these cases the excess production of cortical hormones by the tumor causing the metabolic changes apparently causes a functional atrophy of the opposite gland. There may also be an actual atrophy, as was shown in one of our patients. An apparently normal shadow in another case was of a low functional gland.

(*e*) That metabolic changes practically alone, outside of those produced by sex hormones, can occur with adrenal tumor has been shown by one of our cases. This patient with a Cushing's syndrome had no recognizable amounts of either male or female hormones in her urine. Air insufflation for diagnosis in this case was difficult. The outlines of the adrenal were poorly shown, due to the fibrotic lobulated perirenal fat. A series of films gave a

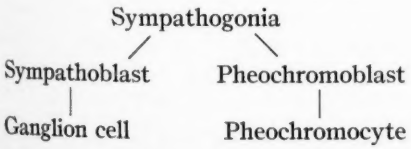


Figs. 19–20. Films of a woman with male characteristics and other changes, more marked, resembling Cushing's syndrome. In Fig. 18 (left) the air outlines the kidney well and the lower portion of a large tumor above the kidney. Fig. 19, taken twenty-four hours after injection, shows air only partially infiltrating between the tumor and the liver. At operation the capsule of the tumor was adherent to that of the liver in this place.

composite picture of a tumor on one side and an apparently normal adrenal upon the opposite side. Removal of the tumor by operation showed that the fat of the perirenal fascia was as suspected. Subsequent death from adrenal failure and autopsy proved that the opposite adrenal, although shown to be present by air insufflation, was atrophic and its cells were apparently functionless.

TUMORS OF THE ADRENAL MEDULLA

Tumors of the adrenal medulla have been classified upon an embryological basis by Goldzieher (19). They may arise from the following types of cells:



Clinically there are two types of tumor, the non-hormonal and the hormonal. The non-hormonal tumors occur mostly in interuterine life or in infancy. They are extremely rare in adults. They are of the ganglion-cell type and are called sympathoblastomas or neuroblastomas. They are very malignant when the cells are immature, are invasive, and metastasize early and widely. The difference in distribution of the metastases led to a description of two clinical types, one, described by Pepper (20), with hepatic and visceral metastases secondary to disease of the right adrenal, and the other by Hutchison (21) with orbital, and skull metastases secondary to a left adrenal tumor. For a differential diagnosis of these tumors in infants we have not used air insufflation. They are to be differentiated from Wilms' embryonal tumor of the kidney. Intravenous or subcutaneous secretory urograms have shown in Wilms' tumor either a completely functionless kidney, or at most a small secreting calyx or calyces in some portion of the mass. In the adrenal medullary tumors the kidney usually is functioning, with an apparently normal pelvis and calyces, but is displaced downward by the suprarenal mass. Since both of these tumors are highly malignant and since frequently both their surface and the surrounding fascia show marked vascularity, we have not used air insufflation because of danger of air embolism, possible dissemination

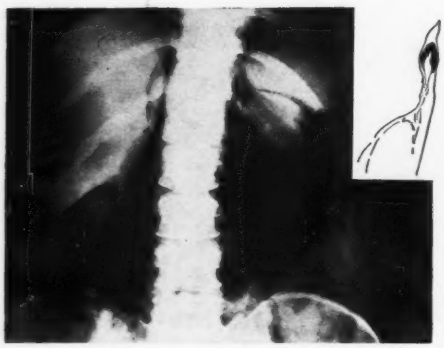


Fig. 21. Film of a female with paroxysmal hypertension. The insufflated air shows a rather "twisty" right adrenal with a wide adrenal notch. The kidney is ptosed. The left adrenal looks normal. The sketch shows a pheochromocytoma with the cortex of the right adrenal as seen at operation in this case.

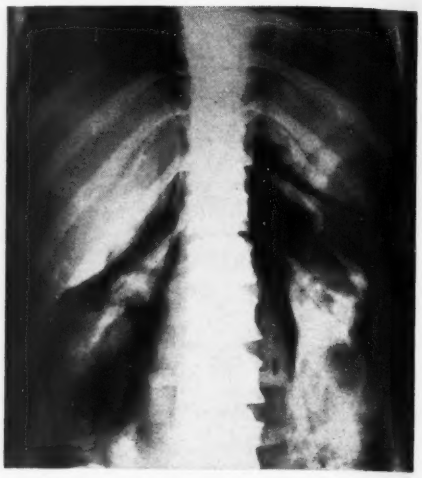


Fig. 22. Film of a female with paroxysmal hypertension. The air shows an apparently small normal left adrenal. The right adrenal is normal above, somewhat deformed, and seems to expand out into a soft lower portion where a pheochromocytoma was suggested.

of the tumor by needle injury, and a resulting hematoma, and since sufficient data for a differential diagnosis may be obtained by secretory pyelography.

Hormonal medullary adrenal tumors are rare. The secreting cell of the adrenal is the pheochromocyte and the tumors are called pheochromocytomas. The term paraganglioma is used for tumors of similar cellular origin and function occurring in other parts of the sympathetic nervous system, especially the preaortic plexus, the carotid body, and the sacral body. These tumors in the adrenal are small, mostly benign, and usually unilateral. They have occurred only in adults. The syndrome that they produce is called paroxysmal hypertension and has been shown to be due to a marked excess of adrenalin introduced into the blood circulation by the tumor cells, under excitement or exercise.

Four cases of supposed paroxysmal hypertension were studied in which air insufflation was used to determine, if possible, whether a change could be seen in the adrenal upon the films that could be interpreted as tumor. In two cases there was no change from normal in the adrenals or in the adrenal notch. In the other two, both on the right side, there was a widening of the adrenal notch and a slight distortion of the adrenal shadow. Operation performed in one disclosed that the widening of the notch was due to a pheochromocytoma of soft consistency and low density. On its anterior surface was the remainder of the adrenal cortex, which showed the only adrenal shadow. The second case presented similar air shadows. From this very limited experience with these rare cases it seems that air will not outline well these very soft, low-density tumors, but will show an increased width of the adrenal notch on the right side and may show some distortion of the denser adrenal cortex. It is essential to determine if possible the side upon which the tumor occurs because of the high hazard in operative handling. Also, since these tumors cause no atrophy of the cortex of the opposite adrenal, the presence of the latter, as shown by air injection roentgenograms, is a comfort to the surgeon faced with the necessity of removing the entire tumor-bearing adrenal.

SUMMARY

A clinical classification of adrenal tumors of both cortical and medullary origin is

reported. The use of air insufflation roentgenography in each type is discussed, and indications and contraindications are presented. When indicated the method has been found to be a fairly reliable one to determine whether or not tumor is present and also to determine whether there is an adrenal present on each side.

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DISCUSSION

James A. Joelson, M.D. (Cleveland, Ohio): I am grateful for this opportunity to hear Dr. Cahill's admirable contribution. He is undoubtedly one of the foremost authorities on the subject of adrenal tumors and has had a tremendous clinical experience with them. His excellent diagnostic efforts and surgical results are well known to all of us and his present record of several hundred insufflations without an accident is truly remarkable.

In spite of a much smaller series, we at Lakeside Hospital have not been so fortunate. Although we have had no fatalities as a result of the method, there were several patients in whom alarming symptoms were produced, probably as the result of air emboli. And in studying the literature, one must finally—although unwillingly—arrive at the conclusion that perirenal insufflation is not entirely without danger. A fair number of fatalities have been reported and I believe that these will occur no matter which technic or gas is used. In spite of this, the method is an excellent one and should be used when definitely indicated.

In the majority of those patients in whom an adrenal tumor is suspected, the presence or absence of such a tumor can be definitely established only by this method or by surgical exploration. In a fair percentage of cases the adrenal tumor can be demonstrated in the plain film of the renal region as a soft tissue shadow just above the kidney, or the pyelogram may reveal a displaced kidney without the distortion of a renal tumor, and finally in some cases areas of calcification may be apparent within the tumor. But in most instances the insufflation of air will be necessary to prove the presence of an adrenal tumor or to rule out definitely the possibility of such a lesion.

We have recently had four patients with adrenal tumors. In all of these the diagnosis was established by means of x-ray studies and proved by operation. Two of these cases were examples of the very rare medullary adenoma or pheochromocytoma, each patient presenting a fairly typical clinical syndrome. Although Dr. Cahill feels that this type of tumor may not cast a definite shadow on the x-ray film, we did not find this to be the case, possibly because of the larger size of the tumors in our patients.

Roentgen films in the four cases of adrenal tumor—two pheochromocytomas and two cortical adenomas—demonstrated the following facts: that the tumor can frequently be suspected as a soft tissue shadow above the kidney; that areas of calcification may sometimes be seen in the adrenal region, indicating the possibility of an adrenal tumor; that adrenal tumors can be demonstrated very clearly in the roentgenograms following the perirenal injection of air.

Perry McCullagh, M.D. (Cleveland, Ohio): It has been a privilege to listen to Dr. Cahill's report of his extensive experience with the air insufflation method. I gain the impression that this method is at its greatest disadvantage in cases of very large or very small adrenal tumors, and at its greatest advantage in those of medium size, which can only be suspected clinically, but cannot be proved.

For the diagnosis of the very large tumors, palpation may suffice, or the tumor may displace neighboring organs sufficiently to declare itself. Very small cortical tumors, although common, fortunately are

usually asymptomatic. Some of the pheochromocytomas or paragangliomas, however, which were associated with severe symptoms, have been no larger than a cherry, according to the reports. Tumors of this size obviously must be found by surgical exploration in most instances, if they are to be found at all. If the problem is kept clearly in mind, the diagnosis often can be made with fair certainty without other help.

In some of our cases we have refrained from injecting air where we might otherwise have done it. In two of these cases, nephrectomy had been performed on the same side and it was felt that the tissues would be distorted and prevent proper dissemination of the air. In two patients suspected of having a medullary tumor, we refrained from the use of air injection because in the first the paroxysms of hypertension were associated with extremely severe angina, and in the second, with severe pulmonary edema. In each instance it was feared that precipitation of an attack might cause death. For this reason it was thought prudent to use only one anesthetic and to explore surgically.

I should like to ask Dr. Cahill what he considers to be distinct contraindications to the use of this test.

Since we must choose on the basis of other findings the cases which should have air insufflation, a few considerations regarding the diagnosis of adrenal cortical tumors may be timely. A clinical picture indistinguishable from adrenal cortical tumors may be associated with tumor of the pituitary gland It is likely, even in the presence of pituitary tumor, that the symptoms are due to adrenal hyperactivity. Rarely a similar picture may follow tumor of the thymus. Masculinizing tumors of the ovary may be confusing in some cases, but these are more likely to cause a picture of pure masculinity without such symptoms as obesity and hypertension.

Assays for urinary androgens may be helpful in the diagnosis, but an androgen assay is not infallible. Within the past few weeks we have seen a sixteen-year-old girl with all the signs of Cushing's syndrome, with extremely high urinary androgens—about twice the upper limits of normal for a male adult. This patient had a pituitary tumor. We feel that in such cases the symptoms also come from the adrenal.

The occasional feminization caused by adrenal tumors is extremely interesting. It is worth noting, in this respect, that a certain degree of feminization can be caused by male hormones. Selye caused gynecomastia in rats by injecting testosterone, and we have seen it in man following the oral use of methyl testosterone. Also, very high excretion of estrogens follows the injection of testosterone propionate, as has been reported by Callow, Hamilton, and others.

Almost all of the symptoms and signs of adrenal cortical tumor can now be adequately explained on the basis of known adrenal hormones. I mention this because I feel that it is important to keep the physiological background in mind.

Desoxy-corticosterone may cause hypertension, edema, and marked shifts in sodium and potassium levels in the blood and urine.

Corticosterone and related substances have a rather marked effect upon carbohydrate metabolism, and probably with the not infrequently associated diabetes in adrenal tumor.

Androgens can account for amenorrhea, clitoral growth, and hirsutism. In addition, the use of large doses recently has been shown to cause redness of the face, elevation in the blood count, acne, and an increased basal metabolic rate, which is encountered in some cases of adrenal tumor. A peculiar chemical change seen in two of our cases was a marked alkalosis, with tetany in one; the blood chlorides were normal in both instances.

George F. Cahill, M.D. (*closing*): Injection of air into the perirenal fascial planes is accompanied by the hazard of air embolus. This is more apt to be true in the larger tumors with tortuous, thin-walled blood-vessels. Therefore, this procedure is not usually recommended for such cases.

It is especially useful in the presence of small tumors which cannot be demonstrated in any other manner; among these are the pheochromocytomas. These, because of the operative hazards they present, should be given the benefit of this diagnostic procedure before exploration, to ascertain which adrenal is affected.

The amount of air to be used varies with the size of the patient and the type of disturbance. The Cushing syndrome type of patient with edema and fat deposits requires more air for demonstration of the tumors than a thinner person.

If care is taken the risk is slight and air insufflation films have a definite value in adrenal conditions.

The Use of Intravesical Low-Voltage Contact Roentgen Irradiation in Cancer of the Bladder[1]

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FOR MANY YEARS we have had at our command five methods of dealing with carcinoma of the urinary bladder. These are fulguration, either transuretheral or *via* suprapubic cystotomy; implantation of radium needles or radon seeds; resection of part of the bladder wall; total cystectomy; external x-ray therapy. Each of these methods has its field of usefulness, and all of them will continue to be employed. Transurethral fulguration of small papillomatous growths of low-grade malignancy will yield, in skilled hands, a high percentage of five-year cures. Since bladder tumors tend to metastasize late, and since the bladder has remarkable power to regain its capacity, resection is a satisfactory procedure for the treatment of those tumors to which it is applicable. Although good results have been reported by some workers, the use of radium and radon implants has not been, in general, very satisfactory. External radiation therapy has been reserved, and properly, for advanced cases which have no prospect of cure by surgery, and can scarcely be considered among the curative procedures.

When those tumors which may be treated either by fulguration or by resection have been excluded, there remains a group of neoplasms involving the trigone, one or both ureteral orifices, or the bladder neck, and for these the surgeon must resort to total cystectomy. This is a formidable procedure, involving transplantation of the ureters, and is accompanied by a primary mortality of at least 50 per cent. It is to replace this operation that we have proposed the use of intravesical low-voltage contact irradiation as a method carrying little or no risk, and with a fairly hopeful outlook as a curative method.

In a previous communication,[2] we described a method in which we marsupialized the bladder and subsequently gave a series of treatments with the x-ray tube introduced into the organ and in contact with the lesion. Since that time we have made certain observations which have led us to introduce a number of changes in the technic employed. These observations were as follows. (1) Marsupialization and fractional irradiation require an unduly prolonged hospitalization. (2) Although theoretically easy, actually the repeated localization of the lesion is very difficult. (3) Repeated anesthesias are hazardous and expensive. (4) Contrary to our first impression, fairly severe reactions occurred rather late after the final closure. We have abandoned marsupialization, therefore, in favor of repeated cystotomy, opening and reopening the bladder either two or three times. The necessary hospitalization is thus reduced to three or four weeks as against six or seven weeks previously required. Complete visual control of the application of the x-ray tube is permitted, and the patient needs only two, or sometimes three, anesthetics instead of the ten to fifteen formerly employed. The amount of radiation given at each application is materially increased but the total amount has been greatly decreased.

It is unnecessary to review the procedures which are requisite for the establishment of a diagnosis of bladder cancer. It will suffice to say that a careful history,

[1] Presented before the Radiological Society of North America at the Twenty-sixth Annual Meeting, Cleveland, Ohio, Dec. 2–6, 1940.

[2] A New Approach to the Treatment of Certain Bladder Carcinomas. Radiology **34:** 205–213, February 1940.

TABLE I: RESULTS WITH INTRAVESICAL LOW-VOLTAGE CONTACT THERAPY IN CANCER OF THE BLADDER

Case No.	Age	Sex	Symptoms and Duration	Type and Grade, Tumor	Diam. (in cm.)	Location	Total r	r per Treatment	First to Last Treatment (days)	Times Treated	Clinical Result	Final Biopsy*	Complications	Elapsed Time
1	41	F	Hematuria 3 mo.	Papillary II	1.0	Left ureteral orifice	5,000	5,000		1	No evidence tumor	None	Surgical parotitis	19 mo.
2	54	M	Hematuria 6 mo.	Papillary III	1.5	Right ureteral orifice	15,336	7,668	9	2	No evidence tumor	Neg.	Auricular fibrillation	6 mo.
3	57	M	Frequency, hematuria 6 mo.	Papillary III	2.0	Right ureteral orifice	22,000	7,500	13	3	No evidence tumor	Not done	None	9 mo.
4	58	M	Frequency, hematuria 3 wk.	Infiltrating III	3.0	Left ureteral orifice	15,336	7,668	8	2	Reaction still present	Neg.	None	1 mo.
5	54	M	Burning, hematuria 2 mo.	Infiltrating III	2.0	Right ureteral orifice	20,448	7,000	17	3	No evidence tumor	Neg.	None	7 mo.
6	51	M	Burning, hematuria 6 mo.	Infiltrating III	2.5	Trigone	23,000	7,500	21	3	No evidence tumor	Neg.	None	7 mo.
7	57	M	Hematuria 10 mo.	Infiltrating III	2.5	Left ureteral orifice	28,116	2,556	36	11	No evidence tumor	Neg.	Contracted bladder	11 mo.
8	65	F	Hematuria 6 wk.	Infiltrating IV	2.0	Left ureteral orifice	28,116	2,556	36	11	Tumor present	Tumor cells present	None	12 mo.
9	62	M	Hematuria 10 yr.	Infiltrating III	5.0	Trigone	15,336	5,112	26	3	No evidence tumor	Not done	None	3 mo.
10	50	F	Dysuria, hematuria 6 mo.	Infiltrating II	2.0	Right ureteral orifice	30,672	2,556	26	12	No evidence tumor	Not done	Metastases	Dead
11	51	M	Dysuria, hematuria 3 yr.	Papillary II	2.0	Right ureteral orifice	20,448	2,000	21	10	No evidence tumor	Neg.	None	17 mo.
12	68	M	Hematuria 2 1/2 yr.	Infiltrating III	3.0	Bladder neck	23,304	7,500	14	3	No evidence tumor	Not done	None	10 mo.
13	69	M	Frequency, hematuria 3 mo.	Papillary III	2.0	Trigone	19,190	6,200	15	3	No evidence tumor	Neg.	Pneumonia	6 mo.

* "Neg." means "no tumor cells found."

physical examination including palpation through the rectum or vagina, cystoscopy, biopsy, and intravenous urography are essential if treatment is to be intelligently planned and carried out.

Before describing the technic which we now use, it will be pertinent to discuss briefly the rationale of the radiation therapy to be employed. One may state as axiomatic that the objects to be achieved in any form of radiation therapy are a maximum of destruction of tumor cells and a minimum of injury to normal cells overlying, underlying, and surrounding the tumor. In the present instance, the overlying tissues are effectively protected in that they receive no radiation whatever, since they are severed and retracted. Because of the extremely short anode-surface distance employed (about 25 mm.), the long wavelength of the radiation, and the depth distribution (about 30 per cent of the surface dose at a depth of 1.0 cm.), the underlying tissues receive a minimum effect, while the very small field employed limits the effect sharply to the area being treated. It thus becomes possible to give rather large doses to the lesion without fear of irreparable damage to the surrounding tissues.

Under spinal anesthesia, the patient is catheterized and the bladder is filled with water. The anesthetic used in this series was spinal novocain. A mid-line incision 6 to 10 cm. long is made upward from the symphysis. The incision is carried through the subcutaneous tissues and the anterior layer of the rectus fascia, and the recti are separated by blunt dissection in the mid line. After retraction, the bladder with its coverings is palpated, the prevesical and subperitoneal fat is pushed upward with the gauze-covered finger, and the peritoneal reflection from the anterior abdominal wall is retracted, with the fat, to the dome of the bladder. Adequate exposure of the bladder wall at this point is essential to subsequent visualization. The bladder is now stabilized by forceps and opened by sharp dissection. The incision in the bladder is enlarged, a Judd-Mason retractor is inserted, and the trigone and the urinary orifices are located in relation to the tumor outline. At this point a bimanual examination with one finger in the rectum or vagina and another in the bladder outlines the area of induration. A biopsy specimen is again taken and the tumor is reduced by fulguration to the level of the bladder wall; bleeding is thus controlled and a considerable amount of necrotic material is disposed of, reducing the bulk of the tumor to be irradiated.

The x-ray tube (which is a metallic cylinder measuring 23 × 1 3/8 inches) has been scrubbed with alcohol and covered with a sterile piece of stockinet. Over this is placed a thin sterile rubber sheath, closed at its distal end. Thus dressed, the tube may be inserted into surgical wounds with impunity. It is introduced into the bladder, and its end brought into contact with the lesion. If the area to be treated is less than 3 cm. in diameter, one of a series of localizing cylinders is employed. These are metal cylinders having circular openings of various sizes in their ends. In use, one is placed in the bladder so that the tumor falls within the opening, thus protecting the surrounding tissues and insuring the maintenance of the tube in proper position. Half of the dose is given, after which the tube is removed and the field inspected to make certain that the rays are being accurately directed. The tube is then replaced and the treatment is continued. Our usual dose is 7,668 r, the technical factors being 50 kv. constant potential, 2 ma., anode-surface distance 2.5 cm., half-value layer 1.0 mm. Al, r afflux 1,278 per minute. The tube and localizing cylinder are removed, the field is inspected, any bleeding points are fulgurated, and the bladder is closed with a running chromic suture in one layer around a mushroom catheter which is placed in the dome as far as possible above the symphysis to reduce the hazard of sinus formation. We have also found that a chromic suture through the bladder above the catheter, *i.e.*, in the

dome, and through the rectus fascia anchors the bladder to the anterior abdominal wall and prevents the empty bladder from sinking into the pelvis if the catheter is accidentally pulled out. A Penrose drain is placed in the space of Retzius, and the fascia is closed with interrupted chromic gut and the skin with a Stewart stitch of retention dermal. The catheter is tied to the skin.

The surgical care between the first and second stage consists of usual dressings and a daily bladder lavage through the suprapubic catheter with 1:16,000 potassium permanganate. No particular postoperative symptoms are to be anticipated at this stage. After seven to ten days the second stage is performed. The sutures and suprapubic catheter are removed, the incision is reopened in one layer, the edges of the wound are retracted, and the tumor site exposed. Invariably the tumor site will be represented by a grayish necrotic area having the size and shape of the distal end of the x-ray tube. One or more sections are removed for microscopic study, and radiation is given as described above. The wound is now closed in two layers. The first layer includes the bladder wall, recti, and fascia, and is closed with interrupted sutures of chromic gut. The catheter is tied in the old sinus tract and the skin closed as in the first stage. As the space of Retzius has not been opened at this stage drainage is not employed.

The necessity of a third stage is determined by (*a*) the histologic report following the second stage; (*b*) the type and extent of the original tumor; (*c*) the amount of infiltration and induration remaining; (*d*) the extent and nature of the radiation reaction that is present. When a third stage is performed it is carried out seven to ten days after the second stage and in a like manner.

As soon as the tissues have sealed themselves off, usually after eight to nine days, the suprapubic catheter is removed and the bladder allowed to heal, with an indwelling urethral catheter.

In our previous paper we stated that no material reaction was observed. Experience now proves that bladder tenesmus occurs after three weeks, and that there will be some sloughing of tissue. Although tenesmus is usually mild, two patients required small doses of narcotics for a period of three weeks. Sloughing tissue is passed in the urine, and one of our patients passed a large piece of necrotic membrane four months after leaving the hospital. For the first three postoperative months the bladder is lavaged with potassium permanganate as required, a urinary antiseptic is given, and the urine is acidified to prevent encrustation of the sloughing area. We think that there should be inspection with a cystoscope every three months for a year, and every six months thereafter for four or five years. We have had no surgical mortality in our series.

In all but one of the comparatively small series of cases we have studied, cystoscopy has indicated the total disappearance of the tumor from six to eighteen months after treatment. One patient has a persistent malignant growth. In most of the cases a white scar represents the former location of the tumor.

CONCLUSIONS

We have now had one and one-half years' experience with this combined surgical-radiation method in the treatment of cancer of the bladder. Our original method has undergone considerable modification, evolving into what we consider a satisfactory procedure. The immediate results have been very encouraging and, although the interval is not yet sufficient to permit a complete evaluation, we believe that time will demonstrate the superiority of this procedure over total cystectomy.

Note: We wish to express our sincere thanks and appreciation to Drs. Frederick A. Bennetts, Jay J. Crane, E. L. Christeson, D. Buie Garstang, John S. McAtee, and Paul R. McGill for their valuable co-operation, assistance, and helpful suggestions.

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DISCUSSION

U. V. Portmann, M.D. (Cleveland, Ohio): When Drs. Goin and Hoffman presented a paper before this society last year on the marsupialization method of treating cancer of the bladder with contact irradiation, their title was "A New Approach for the Treatment of Certain Carcinomas of the Bladder." This title indicated that they recognized certain limitations to this method. Perhaps Dr. Goin will tell us what types of cases he thinks are amenable to this form of therapy.

In discussing the treatment of malignant tumors by a surgical or radiological technic, it is necessary to take into consideration the growth characteristics, location, and extent.

The growth characteristics of carcinomas of the bladder vary considerably. About 75 per cent of all cancers of the bladder are of the so-called papillary type. The sessile type occurs less frequently and has quite different growth characteristics, being more highly differentiated. Both types originate from the same kind of epithelial cells. Papillary tumors usually are multiple, grow outward from the bladder wall, have abundant stroma covered by layers of epithelial cells, and may exist as benign esions for many years until something happens to them that makes them become malignant. The sessile type seldom is multiple, grows in the opposite direction, that is, into the bladder wall, which is infiltrated earlier than with papillary carcinoma.

Tumors of the latter type can be diagnosed earlier because in them blood vessels lie close to the epithelial cells covering the papillae; therefore, superficial ulceration of the tumor results in hemorrhage which calls attention to the new growth. The fact that the papillary tumors are more vascular is probably the reason why they are more radiosensitive than the sessile type.

In regard to location and extent, Dr. Goin has pointed out that a large percentage of carcinomas of the bladder occur in the region of the trigone and, therefore, are inaccessible to surgical attack. The authors have given us a new method of irradiating tumors in this location. It seems to me, however, that the extent of growth may limit the applicability of this procedure.

It must be difficult to apply the radiation accurately to a large tumor without overlapping, and so that the dose in one area will approximate that in another.

We have tried the marsupialization technic but found it impossible to irradiate the tumors homogeneously; also, the bladder contracted by the time we wished to give a second treatment so that the contact tube could not be inserted.

No doubt the technic suggested offers a great deal for certain types of carcinoma of the bladder. I should like to know what governs the selection of cases.

Lowell S. Goin, M.D. (*closing*): We think that this treatment should be confined to tumors which involve the trigone, since there are other methods of treatment which are fairly easy and fairly successful for involvement of the dome and lateral walls of the bladder and it probably is not worth while to subject the patient to two or three surgical operations, plus irradiation, if there is a reasonable chance of cure some other way. We think, therefore, that in the first place the method should be limited to tumors involving the trigone. Second, we think it probably should be limited to tumors not greater than 3 cm. in diameter.

In the case we showed, we used two fields, and Dr. Portmann is quite correct as to the impossibility of exactly evaluating the dosage, since the fields had to overlap. Fortunately, because of the very poor depth dose distribution, this probably does not matter very much, since the overlapping of the fields occurred in malignant tissue.

Briefly, the criteria we should observe are a tumor of comparatively small size and involvement of the trigone. The tumor should not be too small, for very small tumors of low-grade malignancy can be treated transurethrally, which is easier and safer and less expensive for the patient. Many tumors, however, are too large to be treated transurethrally and infiltrating tumors involving the trigone of the bladder that cannot be treated thus, and that do not exceed 3 cm. in diameter, which will probably be half of all the bladder tumors one sees, are the ones we believe should be treated by the procedure we have described.

Further Experiences with Chaoul Therapy[1]

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In 1937 we presented our experiences with short-distance low-voltage roentgen therapy before the Fifth International Congress of Radiology (2). At that time we had treated but 80 patients with various neoplastic and inflammatory conditions. We have had the opportunity of treating many more lesions by this method since then. The purpose of the present communication is to record the results of further experiences with short-distance low-voltage irradiation.

PHYSICAL DATA

Our experience has been limited to the use of the Chaoul unit for "contact" therapy which was installed in our department in March 1936. Briefly, the x-ray tube is activated by a constant potential generator using a modified Greinacher circuit. The tube itself is a modification of the old Lenard ray tube in which the electron beam passes down a grounded metal cylinder, striking at the end a target of gold-plated nickel. The rays emerge through the target, which, therefore, acts as part of the filtration. In addition the beam passes through the cooling water (2 mm.) and a thin metal foil window, which forms part of the water jacket. The total inherent filtration, as stated by the manufacturer, is approximately equivalent to 0.2 mm. of nickel. While the rated capacity of the tube is 60 kv., 4 ma., we have chosen to operate it at 50 kv., 4 ma. The original tube is still in use, the output being about the same now as it was when first measured.

The half-value layer of the emerging beam is 2.4 mm. aluminum. The effective wavelength was found to be 0.38 Å. The focal spot measured approximately 1.6 cm. in diameter (pinhole 0.4 mm. in diameter, 61 cm. pinhole-film distance).

Mayneord called attention to the radial variation of intensity in the emerging x-ray beam (1). We found that the intensity fell off 30 to 40 per cent toward the periphery of the field. While the inverse square law of variation in intensity with distance could not be assumed to hold with such a large focal spot at short distances, our investigations revealed that a close agreement did exist.

The back-scatter of the rays emitted by the Chaoul unit varies directly with portal area, approaching a limiting value of about 20 per cent for the largest cone, measuring 4.6 cm. in diameter. The back-scatter for the smallest cone, 2 cm. in diameter, is about 7 per cent. The difference in percentage back-scatter between target-skin distances of 3 cm. and 5 cm. was found to be negligible.

The percentage depth dose varies from 65 to 24 per cent at 1-cm. depth as the target-skin distance decreases from 5 cm. to 3 mm. The differences in depth dose with varying target-skin distances are summarized in Table I.

TABLE I. PERCENTAGE DEPTH DOSE AT VARYING DEPTHS IN WATER PHANTOM
(Chaoul unit: 45 kv. 4 ma.)

T.S.D.	0.5 Cm.	1 Cm.	1.5 Cm.	2 Cm.	3 Cm.
3 mm.	50%	24%	14%		
3 cm.	72%	53%	38%	27%	15%
5 cm.	85%	65%	50%	40%	23%

Not enough emphasis has been placed upon the protection of the operator during the treatment of the patient. Indeed, there is a tendency to minimize the dangers to the stray radiations emitted during short-distance low-voltage irradiation. Mayneord (1) observed that the tolerance

[1] From the Department of Radiology of the Hospital of the University of Pennsylvania. Presented before the Radiological Society of North America, at Cleveland, Ohio, Dec. 2–6, 1940.

dose of 10^{-5} r per second, for stray radiations emitted during short-distance low-voltage irradiation, was obtained in air at a distance of 3.2 meters from the point of contact between the applicator and the patient. Thus he found that the dose rate at 2 meters was 2.3×10^{-5} r per second; at 1.5 meters was 4.2×10^{-5} r per second, and at 1 meter was 9.6×10^{-5} r per second. In the direct beam the tolerance dose rate is reached at 60 feet from the tube. Fortunately these scattered rays are so soft that the thinnest lead screens afford ample protection. In our department the operator is protected from the patient by a wall lined with 1/32 inch lead. Radiologists and technicians being constantly exposed to stray radiations during the day's routine, it seems reasonable to take every precaution against unnecessary exposure even though, at the time the patient is being treated, the exposure seems insignificant.

The advantages of short-distance low-voltage roentgen therapy are many. The effects of such irradiation being confined to small volumes of tissue, one may deliver large quantities of radiation to an involved area without permanently injuring the tumor bed. The high output of radiation (125 r per minute at 5 cm. T.S.D., 300 r per minute at 3 cm. T.S.D., 700 r per minute at 1.5 cm. T.S.D., and 2,700 r per minute at 3 mm. T.S.D.) allows one a considerable saving in time. In this respect, however, it must be remembered that the output from different x-ray tubes connected into the same generating apparatus may vary as much as 100 per cent and must therefore be closely checked.

The Chaoul unit is extremely flexible and easily adapted to treating areas about the eyes and nose. It has been our experience that many areas in the mouth, such as the posterior gingival margins, hard and soft palate, and posterior half of the tongue, are not readily amenable to such therapy.

Financially, short-distance low-voltage equipment is economical. The original outlay is much smaller than that required for an equivalent amount of radium capable of handling the same number of patients daily. The upkeep is negligible. It is fair to state, however, that the use of the Chaoul apparatus and other similar units is definitely limited.

INDICATIONS AND CONTRAINDICATIONS

Accessibility of the lesion is essential for short-distance low-voltage therapy. Unless the entire lesion can readily be included in the field of irradiation other methods must be resorted to. Skin lesions, lesions of the lips, eyes, anterior half of the tongue, anterior portions of the gingival margins, floor of the mouth, and outer portions of the buccal mucosa are usually accessible and easily treated.

Owing to the rapid fall-off in depth dose inherent in the method, extreme care must be taken not to treat lesions over 1.5 to 2 cm. in thickness. It is probably safer to limit the use of short-distance low-voltage irradiation to lesions 1 cm. or less in thickness. When thicker lesions are irradiated (1.5 to 2 cm. in thickness) a T.S.D. of at least 5 cm. should always be employed.

The superficial lesion ideal for this form of irradiation does not cover too large an area. Large lesions necessitate the use of multiple portals. When more than five or six portals are required there exists the danger of an uneven distribution of radiation over the treated area. Under-irradiated areas with recurrence and over-irradiated areas with delayed healing frequently ensue. Such lesions are probably best treated with intermediate voltages and at very short target-skin distances.

In our experience cartilage does not seem to tolerate this form of therapy as well as it does irradiation at higher energy levels. Notoriously prone to chondritis with higher voltages, cartilage seems even more susceptible to short-distance low-voltage therapy. This complication may be avoided if the total dose is fractionated over a longer period of time, the daily dose not exceeding 300 r.

DOSAGE AND DOSE ADMINISTRATION[2]

In 1937 we suggested that the total tumor dose to be delivered to neoplasms by this method could not be arbitrarily selected before treatment was begun. Instead, it was felt that the total amount of irradiation to be employed depended almost entirely upon the reactions of the irradiated area. We are still of this opinion. When patients are first seen no attempt is made to specify the total dose to be used. Past experiences with similar lesions suggest an approximate amount of irradiation that may be necessary, but the total dose is determined only by the reactions in the treated area.

The treatment of small (less than 1 cm. in diameter) superficial tumors is relatively easy. One portal large enough to cover the lesion and a zone of normal tissue around it is usually sufficient. If the area treated is less than 1 cm. in diameter massive doses of 2,000 r may be given at weekly intervals up to a total of 6,000 to 8,000 r. Patients unable to return at weekly intervals receive a single massive dose of 3,000 to 4,000 r. Occasionally it may be necessary to supplement the original massive dose three to six weeks later. In such instances the second dose of 2,000 r will be tolerated if not given within two or three weeks following the first treatment. In reviewing our records we found it was necessary to give additional irradiation to seven patients one to two months after the original course of treatment had been completed. In each instance the supplementary irradiation produced the desired result. As a rule, the supplementary dose was less than the total dose originally given.

In treating areas less than 2 cm. in diameter lead shields perforated to fit the lesion are employed. It must be remembered that the smaller the field used, the higher will be the total dose necessary to produce the desired effect. We have given 9,000 r over a period of twenty-five days to such small areas without observing untoward sequelae.

Tumors larger than 1 or 2 cm. in diameter but which can still be included in a single field are more satisfactorily treated at daily intervals (Fig. 1). A total dose of 5,000 to 6,000 r may be given by this method provided it is fractionated into 300 to 400 r daily doses. Patients treated twice a week will tolerate 600 to 800 r per portal until a total of 5,000 to 6,000 r is delivered. Occasionally patients can return for treatment only at weekly intervals. In such instances 1,200 to 1,500 r per portal may be delivered at weekly

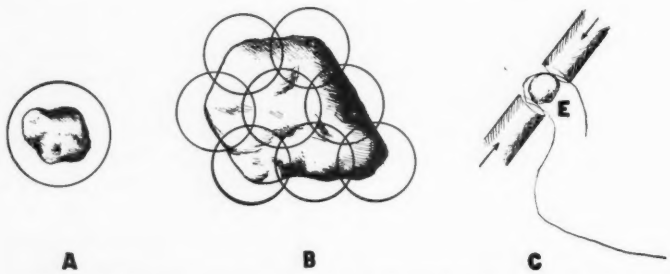

Fig. 1. A diagrammatic presentation of the various methods of distributing portals in short-distance low-voltage irradiation. A. Single portal. B. Multiple portals. C. Cross-fire.

In B the total number of portals is eight. This number is more than is usually recommended. It has been used to demonstrate the method of overlapping portals. In C a carcinoma of the lower lip is presented diagrammatically The neoplasm, which is shaded in the illustration, is indicated by the letter E. The portals employed for cross-firing are indicated by the arrows.

[2] Throughout this paper r indicates r in air without back-scatter applied to the skin.

intervals until 5,000 to 6,000 r have been given. If the tumor has not disappeared after this total dose has been delivered, it is our custom to wait two to four weeks before continuing with additional treatment. Frequently when the patient returns after this interval without treatment, the tumor will have disappeared, making further radiation unnecessary.

Larger (greater than 4 cm. in diameter) and more irregularly shaped superficial tumors must be treated through multiple portals. In such lesions, overlapping in the peripheral portion of each portal is necessary. Outlining these portals is difficult, as over-irradiation and under-irradiation may result if the portals are not carefully spaced. The amount of overlapping is kept to a minimum (Fig. 1). When using circular portals a slight amount of overlapping is necessary in order that the entire surface be covered. An attempt should be made to avoid overlapping three portals in the same area. If more than six portals must be resorted to in order adequately to cover the tumor area, it is probably best to resort to intermediate voltage therapy at very short target-skin distance to assure an even distribution of radiation.

When multiple portals are used patients may be treated at daily, twice weekly, or weekly intervals in the manner outlined for single portals. The entire area should be irradiated when the patient reports for treatment. A lesion treated by the multiple field technic will not tolerate as large a total dose per portal as will the lesion treated through a single field. In such instances 3,000 to 4,000 r per portal fractionated in 300 r daily doses may be given with impunity. In our experience it has been unusual for large surface lesions to require more than 4,000 r to each of the multiple portals. Occasionally portions of the tumor area disappear rapidly while other areas regress more slowly, suggesting variations in radiosensitivity in various portions of the same lesion (Fig. 4). When this occurs the treatment is stopped in the sensitive portions of the tumor and continued where residual infiltration seems present.

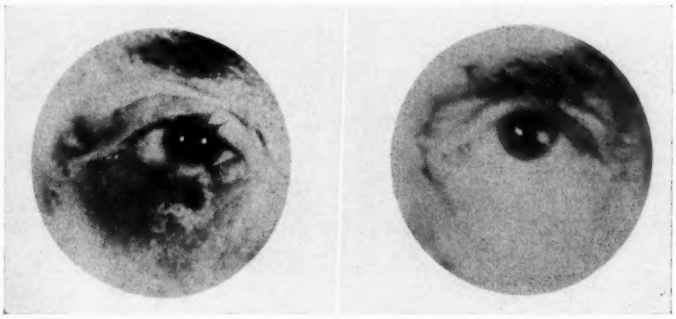

Fig. 2. Spinocellular epithelioma, grade I, involving the lower eyelid treated three and four times weekly for a total of twenty-eight days, receiving approximately 400 r at each sitting. Physical factors: 50 kv., 4 ma., 3 cm. T.S.D., filtration inherent in tube, single portal technic. Total dose 5,400 r applied to the surface. Result: No evidence of local recurrence after three years.

As a rule, we do not treat large lesions requiring the multiple field technic at weekly intervals or even twice a week. Such lesions are more satisfactorily treated daily according to the method of fractionation outlined above.

The method of cross-firing is also employed in short-distance low-voltage roentgen therapy (Fig. 1). Carcinomas of the lip are particularly adapted to this form of therapy, as two portals can be directed into the tumor-bearing area. When cross-firing is resorted to, it is safer to treat

only one portal per day, delivering 300 to 400 r to one portal daily until each portal has received a total of about 3,000 r. Higher daily doses or larger total doses are not infrequently followed in four to eighteen months by indolent post-irradiation ulcers. In our experience most carcinomas of the lip may be controlled by total doses of 5,000 to 6,000 r. Occasionally a total of 7,000 r may be necessary. If the daily increments have been small, there will be no subsequent development of indolent ulcers.

In the majority of cases 400 to 450 r given at one time produce a threshold skin reactions. Apparently sufficient time had not elapsed, as we have since seen six indolent ulcers. In three patients the total dose varied from 6,800 to 8,000 r. In addition these patients received large daily doses (800 to 1,200 r). One patient treated for multiple carcinomas in the tongue developed an indolent ulcer. Our inability to fix the tongue in one position probably resulted in excessive radiation being delivered to the ulcerated area. In one patient an indolent ulcer developed near the cartilage of the pinna of the ear following a total dose of 4,000 r. In one patient with carcinoma of the lip an in-

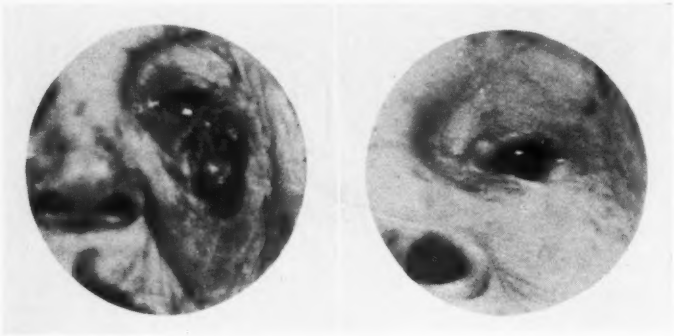

Fig. 3. Epithelioma of the cheek extending to and involving the lower eyelid, treated daily for ten days, receiving 400 to 450 r at each sitting. Physical factors: 50 kv., 4 ma., 5 cm. T.S.D., filtration inherent in tube, single portal technic. Total dose applied to the surface 4,980 r. Result: No evidence of recurrence after four and a half years.

erythema. In spite of the radial drop in intensity the skin reaction is grossly uniform and is confined to the limits of the applicator.

In treating malignant growths, the skin reaction, as a rule, is almost at its height by the time treatment is discontinued. Doses lower than 3,000 r, if fractionated over a period of about ten days, usually produce a dry type of epidermitis, while still smaller doses produce erythematous changes with slight scaling of the skin. The severe changes attending large total doses simulate the *epidermitis exudativa* of Coutard. Almost invariably the skin is entirely healed in about three weeks.

In our previous report we indicated that we had seen no untoward secondary dolent ulcer developed one and a half years after 2,000 r had been delivered to each of two portals. Why this occurred with such moderate dosage has not been satisfactorily explained.

CLINICAL DATA

During the past four and a half years (February 1936–September 1940) we have treated 541 lesions with short-distance low-voltage irradiation, as follows:

Malignant tumors	228
Benign tumors	106
Inflammatory conditions	207

Carcinoma of the Skin: One hundred and twenty-two skin cancers were treated with uniformly excellent results. The

average dose delivered to the skin was 4,500 r, the minimum being 1,600 r and the maximum 13,000 r. The single or multiple field technic was used, depending upon the size of the lesion. The dose was fractionated, giving 300 r per day until the desired result was obtained (Figs. 2, 3, and 4). When patients could be treated only twice a week or once weekly, the treatments were given according to the method outlined above. In seven instances the dose delivered had to be supplemented by additional treatment at a later date. The results following this delayed treatment were uniformly good. In 3 patients in-

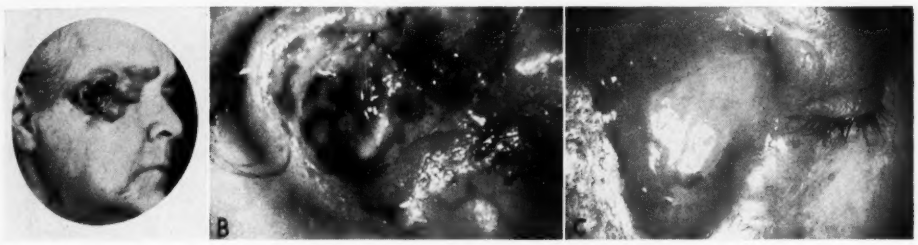

Fig. 4. Basal-cell epithelioma of the temple extending to the outer canthus of the eye. The lateral portions of the upper and lower eyelid were involved. A. Gross appearance of the lesion. B. Close-up on the same date revealing the eburnated edge and ulceration. C. Two weeks after completion of treatment, revealing subsiding irradiation reaction and healing.

Physical factors: 50 kv., 4 ma., 5 cm. T.S.D., filtration inherent in tube, multiple portal technic employed. Treated daily for one month, 200 r to each portal at each sitting. After 2,200 r had been delivered to each of the four portals no residual evidence of disease was present except in that portion of the epithelioma overlying the outer canthus of the eye. This area was treated through a single portal, receiving 200 r daily for a total dose of 2,200 r. Total dose applied to surface, 2,200 r to each of three portals and 4,700 r over the outer canthus of the eye. Result: No evidence of local recurrence after eight months.

dolent ulcers developed following short-distance low-voltage irradiation. Review of the records of these patients suggested that the ulcers could be attributed to an excessive total dose plus an abnormally high daily increment.

It has been our practice not to be influenced unduly by the histology of skin cancers. Every tumor, irrespective of grade or type, is irradiated until all local evidence of cancer disappears. It is interesting to observe how often so-called "basal-cell" epitheliomas respond like the more radioresistant "squamous-cell" neoplasms.

Many ulcerated epitheliomas are secondarily infected. Before delivering large quantities of radiation to such areas care is taken to treat the ulcerated process as a simple infection complicating a neoplasm. To this end, local cleansing with mild antiseptics and physiological salt solution is used. In addition small quantities of radiation, 100 to 150 r, are delivered daily for several days in the same fashion as one would treat an ordinary infection. After several days infected ulcerated lesions take on a more healthy appearance and will then tolerate carcinocidal quantities of radiation more satisfactorily.

Carcinoma of the Lip: Thirty-two patients with lip cancer were treated. The average amount delivered to the surface of the lip was 5,200 r (total dose), the minimum being 2,000 r and the maximum dose 9,100 r. The majority of lip cancers were treated by the cross-fire technic (Figs. 5 and 6). Occasionally the single field or multiple field method was employed.

As a rule 300 to 400 r were delivered daily to one portal. Alternate portals were treated daily until the lesion lost all evidence of induration. The presence or absence of induration was determined by the "feel" of the tumor, extreme care being taken not to traumatize the lesion. Occasionally lip cancers may feel indurated when a marked *epidermitis exudativa* has appeared and a total of 5,000 to 6,000 r has been delivered to the skin areas. It

is our practice to withhold further irradiation in these cases for one or two weeks. If after this time has elapsed the tumor still feels indurated, the fractional doses are resumed and an additional 500 to 800 r are applied to each skin surface. Usually no further irradiation is necessary.

As it has only been four and a half years since this form of treatment was instituted in our department, it is impossible to record results in terms of five-year cures. Our experience leads us to believe that the results will be no better following short-distance low-voltage irradiation than the results obtained by higher voltage or radium technics. The primary lesion in all of the patients with lip cancer remained healed. Two patients had indolent ulcers, one of which healed spontaneously; the second was electro-desiccated. In 4 of the 32 patients with epithelioma of the lip metastatic nodes developed. Of these 4 patients, 2 have died.

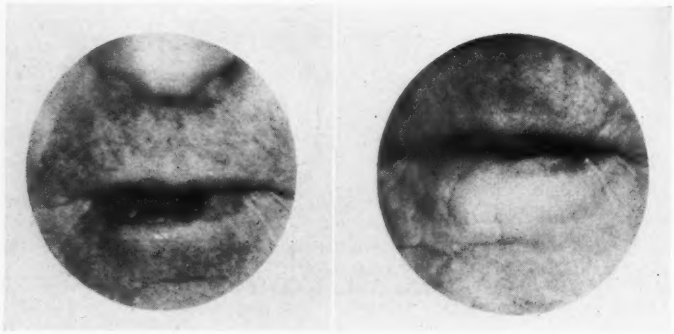

Fig. 5. Epithelioma of the lower lip extending beyond the midline, before and after treatment.

Physical factors: 50 kv., 4 ma., 5 cm. T.S.D., filtration inherent in tube. Cross-fire plus multiple portal technic employed, two portals being directed into the tumor through the inner aspect of the lip and two similar portals being directed into the tumor through the external aspect of the lip. Patient treated daily for two weeks, approximately 300 r being delivered through each of two portals at each sitting. Total dose applied to the surface, 1,600 r to each of four portals. Result: No evidence of local recurrence after four years and four months.

Carcinoma of the Mouth: Nine patients with carcinomas of the mouth received short-distance low-voltage therapy. Two of the patients had carcinomas of the buccal mucosa. One patient received 3,000 r and has remained well. The second patient received 6,000 r, but the lesion was not controlled.

Three patients with carcinoma of the tongue were treated. One received 4,400 r to each of four areas. An indolent ulcer appeared several months later. The malignant lesion recurred sixteen months after the first treatment. This patient eventually died of his disease. The second patient died before sufficient irradiation had been delivered to the tongue. The third died as the result of metastasis, though the tongue remained healed.

Three patients with neoplasms in the floor of the mouth received short-distance low-voltage irradiation. One received 2,000 r and has remained well. Two patients received 7,300 r and 6,800 r, respectively, and in both cases recurrences developed in the irradiated area one year later. Other therapeutic measures were subsequently resorted to. One patient is alive and well, the second died as the result of his disease.

One patient with a carcinoma of the gingival mucous membrane was treated by this method. This patient died before the tumor was adequately irradiated.

Occasionally, in order to facilitate application through an intra-oral portal, it may be necessary to remove several teeth. We do not hesitate to do this if there is evidence of considerable dental infection or if the neoplasm involves the gingival margins. If the teeth are in excellent condition, however, and if the lesion can be adequately treated by some other form of radiant energy, we prefer not to treat the patient with Chaoul therapy unless the applicator can be adequately applied to the tumor without sacrificing healthy teeth.

surgery, by roentgen rays generated at higher energy levels, or by radium.

Angioma: The flexibility and high radiation output of the Chaoul unit make it singularly adaptable to the treatment of hemangiomas in infants. The ease with which any portal can be approached and the short exposure time make this type of therapy a welcome adjunct. From a purely physical aspect, the contact method is preferable to other roentgen technics because of the rapidity with which the intensity falls off at depths of from 1 to 2 cm. Theoretically, this should afford

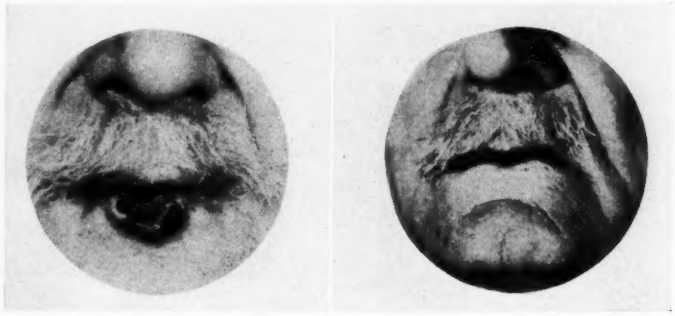

Fig. 6. Spinocellular epithelioma, grade II, involving the mid portion of the lower lip, before and after treatment.

Physical factors: 50 kv., 4 ma., 3 cm. T.S.D., filtration inherent in tube, cross-fire technic. Treated at monthly intervals over a period of four months, 2,000 r delivered to the area at each sitting. Total dose applied to surface, 4,500 r through each portal. Result: No evidence of local recurrence in one and one-half years. Later metastatic nodes appeared in neck.

Carcinoma of the Breast, Recurrences: The recurrent skin nodules of breast cancer are ideally suited for this type of treatment. As a rule, 2,000 to 3,000 r delivered at one sitting will suffice to control these lesions. If the nodules are multiple or an early *en cuirasse* exists, an intermediate voltage technic at short target-skin distance is resorted to in order to permit treatment over a larger area.

Miscellaneous Neoplasms: One carcinoma of the rectum, one carcinoma of the vulva, two bladder neoplasms, and one carcinoma of the penis were treated by the short-distance low-voltage method. Our results in these cases were uniformly unsatisfactory. In our opinion these lesions are more satisfactorily treated by more protection to growing parts that might lie in the course of the beam. We usually deliver from 100 to 300 r at one sitting, the target-skin distance varying from 3 mm. to 3 cm. Such doses are repeated at intervals spaced far enough apart, six to twelve weeks, to allow one to evaluate the rate of involution, thereby avoiding the sequelae of excessive radiation. Five to seven treatments given during a period of six months to one year are usually sufficient. It is obviously impossible to record the total doses necessary for satisfactory results in treating hemangiomas. We should state, however, that some hemangiomas require other types of radiation.

The importance of irradiating angiomas

as early in life as is possible cannot be over-emphasized. Indeed, it is axiomatic that the radiosensitivity of an angioma varies inversely as the age of the lesion. Our best results have been obtained in infants seen during the first one or two months after birth.

Keloids: For years we have satisfactorily treated keloids, employing the following factors: 135 kv., 30 to 40 cm. total skin distance. This technic has been replaced by contact therapy with results comparable to those obtained at 135 kv. The older method is still used for large keloids, as the greater target-skin distances enable one to include the entire lesion in the one field.

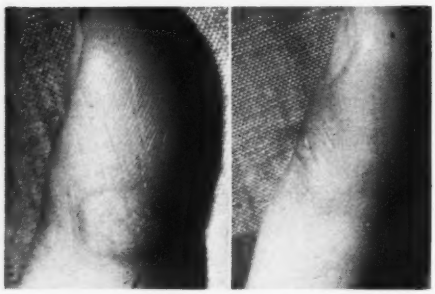

Fig. 7. Wart overlying the distal phalangeal joint of the finger: original appearance (left) and (right) appearance six weeks after the completion of treatment. Physical factors: 50 kv., 4 ma., 3 cm. T.S.D., filtration inherent in tube, single portal technic. Lesion given 2,000 r at one sitting.

As a rule, rapidly growing keloids in young persons respond favorably to small doses repeated over a period of time. Usually from 250 to 350 r, repeated at intervals of four to six weeks on three or four occasions, suffice. Sometimes two treatments are adequate, whereas in other patients as many as eight treatments are insufficient. No rule of thumb governs keloids. One must be guided entirely by the individual lesion and its response to radiation, allowing enough time—months—to elapse to avoid excessive treatment.

Warts (Verruca Vulgaris): The concentration of intensity of radiation near the skin surface has made us change our method for treating cutaneous warts. Whereas we once used 135 kv., 30 cm. distance, we are now using the contact method. Since adopting this plan, we are no longer being troubled by the severe reactions produced by exit radiation. It has been our experience that approximately 2,500 r, if delivered in one dose, are sufficient to remove 98 per cent of the warts (Fig. 7). This amount of radiation, delivered at 3 cm. target-skin distance, requires about eight to nine minutes, whereas formerly approximately twenty-five minutes were required (1,500 r with unfiltered radiation plus 1,100 r with 1 mm. aluminum).

Furuncles: We have used low-voltage

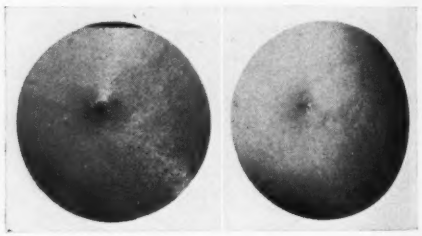

Fig. 8. Furuncle of the cheek, present for one week; considerable edema, pain, no evidence of suppuration: original appearance (left), and appearance two days later (right). Physical factors: 50 kv., 4 ma., 5 cm. T.S.D., filtration inherent in tube. Treated daily for two days, receiving 150 r at each sitting.

therapy successfully in the treatment of small infections all over the body, but nowhere do we use it with more satisfaction than for infections around the eyes, nose, and ears. These areas are particularly suited for the various applicators. Daily doses of from 100 to 150 r usually suffice if repeated once or twice, although somewhat higher doses are necessary in the treatment of axillary furuncles (Fig. 8). All furuncles are treated at 5 cm. T.S.D., as large a skin area as is possible being included.

Vernal Catarrh: Several years ago, one of us (E. P. P., 3) reported the results in the treatment of vernal catarrh by means of radium and radium emanation. At that time we recommended these agents

because they were more easily applied than roentgen rays. This technic has now been replaced, to a large extent, by contact roentgen therapy, because of the more even distribution of its energy. The ease with which the target is applied to the eye is equal to the ease with which emanation was utilized.

After anesthetizing the eyes, the lids are everted and plastic lead is applied to the eyelashes for protection. A special instrument, used to evert the lid, serves as protection to the globe. Each eye is treated at from 3 to 4 cm. distance, about 250 to 300 r being delivered in from one and one-half to two minutes. A similar treatment is usually given in from four to six weeks, following which several months are allowed to elapse. We have given four such treatments to each eye, over a period of one year, before obtaining the desired results. The limitations and prognosis with Chaoul therapy are similar to those for radium and emanation.

Pruritus Ani: The ease with which the applicator is fitted to the anus recommends its use in this condition. Doses of 200 r, repeated once or twice at twenty-four-hour intervals, are usually sufficient to relieve the itching.

Rectal Condylomas: Doses of 200 r, repeated daily over a period of from four to five days, are usually sufficient to remove these lesions. As a rule, the warts regress slowly over a period of about four weeks until they are no longer visible. The itching which frequently attends these venereal lesions disappears within the first few days.

SUMMARY

1. Short-distance low-voltage irradiation is a highly efficient and economical method for delivering large quantities of radiation to small volumes of tissue.

2. The rapid fall in depth dose inherent in the method militates against its use in the treatment of lesions more than 1.5 to 2 cm. in thickness.

3. Principles pertaining to the use of single portals, multiple portals, and cross-firing technics are discussed.

4. Dosage rate and dose distribution with respect to the various types of technic are considered.

5. It is suggested that the total tumor dose to be delivered by this method should depend upon the reactions of the tissues in the irradiated area. It is believed that this method of estimating dosage avoids underdosage of the more resistant portions of the tumor and minimizes the risk of subsequent indolent ulcerations.

6. The system of dosage and dose distribution in the technics employed in short-distance low-voltage irradiation are illustrated by reference to actual cases treated.

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Roentgen Therapy of 100 Consecutive Tumors of the Brain or Spinal Cord[1]

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DURING THE PAST six years, we have had the opportunity to administer roentgen therapy and observe the course of 100 cases with a diagnosis of tumor of the brain or spinal cord at the Hospital of the Medical College of Virginia and the Neurological-Surgical Service of Dr. C. C. Coleman. Ten years ago, one of us with Tracy (39) reported favorably on the roentgen therapy of a small series of cerebellar medulloblastomas. With these experiences, we have been stimulated to read and hear a great deal of what has been written and said, in papers and discussions, concerning brain tumors, especially as concerns the rôle of roentgen rays in diagnosis and treatment.

Our small series is not comparable to the work of Frazier (21) and his group of fifteen distinguished collaborators, who had the pooled material of many outstanding neurosurgical clinics, nor is it like another series of 38 cases following in rapid succession, covering a ten-year period of treatments given by a heterogeneous series of radiologists and residents. It represents 100 cases, treated in one department by a single radiologist, flanked by his resident and assistant, a small coherent group with ideas in complete agreement.

We admit that the survival period is known to vary with different types of brain tumors, that remissions and exacerbations of symptoms occur in untreated cases, that surgical decompressions and surgical removal of tumors are frequently beneficial, that clinical improvement cannot be evaluated accurately, that critical pathologists frequently cannot differentiate changes due to irradiation from changes ordinarily occurring in the natural development of many brain tumors, and that the exact mechanism of the biologic effect of radiation on living cells is only partly known.

Frazier and his collaborators stated that the three classifications of treatment listed, namely, inadequate (less than 1,000 r), moderate (1,000 to 2,000 r), and adequate (more than 2,000 r), probably represented insufficient tumor dosage. To apply such an arbitrary yardstick to tumors ranging from the medulloblastoma to the oligodendroglioma is most unsatisfactory, especially as we have personally seen tumor doses of 5,000 r or over fail miserably. There are so many other factors concerned with the measurement of radiant energy than total quantity—quality, intensity, spacing, portals, etc.—that a study of any one is wellnigh worthless. We have, however, no intention of belittling the work of the collaborators, nor do we wish to evade the responsibility of radiation dosage on technical grounds. We still believe we can measure roentgen energy more adequately than the neurosurgeon can determine the effect of some of his procedures.

Briefly, our technic has been based on 200-kv. apparatus, with a half-value layer of 0.8 to 2.0 mm. copper, an effective wavelength of 0.16 to 0.12 Ångströms, 50 cm. target-skin distance, and large daily total doses of 400 to 800 r measured in air, more usually 500 r to a single portal, or 250 r to two portals. Four portals, 10 cm. in diameter, to the skull, or two posterior oblique portals to the spine have been usual. Total doses in air to each portal have varied from 700 to 1,200 r; occasionally 1,800 r have been given with smaller ports in pituitary cases and in spinal tumors with narrow fields. The cycle has often been completed in five days; although we prefer several weeks, we are seldom allowed so long a time except with out-

[1] Presented before the Society of Neurological Surgeons, at Richmond, Va., May 1–2, 1941. Accepted for publication in June 1941.

patients. A second series is given in six weeks, and three more series at three-month intervals.

Since few patients co-operate in our plan, we attempt to prolong the first series and raise the tumor dose, though we would hesitate to exceed 3,000 r to the tumor in any one series, as we believe in respecting normal surrounding tissues. Recently, we have turned to 400-kv. apparatus, with a half-value layer of 4.4 mm. copper and 70 cm. target-skin distance, with low intensity (r per minute) and 200 r doses, and have given a total of 5,400 r on the skin to one portal for a retinoblastoma in a forty-day period. The tumor, of large size, melted away visibly but no permanent result is claimed or expected. On a purely physical basis, we believe that shorter wavelengths, slightly increased depth doses, and lower intensities, producing more adequate tumor dosage, should be used when available.

One other phase of the present series of cases reported deserves mention. The neurosurgical service has in our opinion been very conservative, in fact restrained, in referring cases for therapy unless the tumor was known still to be present. We should judge that not more than one tumor in three seen for diagnosis is referred for roentgen therapy in our department. It is a practical certainty that in every case referred to us there is tumor remaining to be treated, and, allowing for the natural life histories of these tumors and the benefits of decompressions and partial extirpations, known quantities of roentgen energy cannot rightfully be denied the honor at least of not immediately killing such wreckage. Furthermore, we have the benefit of experience gained in the treatment of visible tumors, from the radiosensitive lymphosarcomas, through the moderately radiosensitive basal and squamous epitheliomas, to the radioresistant fibrosarcomas. We know by actual experience that we have cured, beyond a reasonable doubt, microscopically proved basal epitheliomas of the skin with 2,000 r and failed to cure smaller proved lesions with 10,000 r. In the present inadequate state of our knowledge, there is no reason why similar experiences should not be expected in treating tumors in the brain and spinal cord.

It is true that pre-irradiation microscopic specimens and specimens obtained after irradiation, preferably at autopsy, together with complete clinical, operative, and radiation data are desirable, but we doubt whether the problem of the glioblastoma multiforme group, for example, can ever be solved thus. In the present series such studies are impossible, as among the 100 cases there were 34 deaths with 4 necropsies, 16 patients were untraced, and 50 are still living. Nor are we content to use the glowing term "clinical improvement" so characteristic of the clinician. We report merely in present-day nautical or aeronautical parlance the number of ships still on the sea, or planes in the air, that is to say, the number of patients who have survived the rigors of neurosurgical evacuations and radiologic bombardment of atoms.

Actually in a six-year period 103 cases were treated. One lesion clinically diagnosed as a pontine tumor proved at autopsy to be Schilder's disease, a second was an aneurysm of an artery in the spinal canal, and a third was the retinoblastoma above mentioned. Brain tumors number 76.

Medulloblastoma	12 cases
Glioblastoma multiforme	9
Astrocytoma	5
Ependymoma	4
Astroblastoma	2
Spongioblastoma polare	1
Reticulum-cell sarcoma	2
Sarcoma	1
Hemangioma	5
Hemangioblastoma	1
Meningioma	1
Glioma unclassified	1
Pontine tumors	10
Craniopharyngioma	8
Metastatic tumors	4
Unclassified	10

The pituitary adenomas numbered 8:

Chromophobe	4
Chromophile	3
Mixed	1

Spinal cord tumors were 16 in number:

Glioblastoma multiforme	2
Medulloblastoma	1
Hemangioma	4
Tumor unclassified	7
Metastatic	2

MEDULLOBLASTOMA

Of the 12 medulloblastomas, all were cerebellar; 11 were in males and one in a female, the ages ranging from three to forty years. Ten patients were followed. In one case pre-irradiation and autopsy post-radiation microscopic sections were studied. Five patients are living and 5 are dead. Two patients, each of whom lived four years and five months, died with spinal cord metastases. In a review of the literature, fifteen authors were found who regarded these tumors as radiosensitive; only Davis and Weil (13) mentioned radioresistance. The overwhelming opinion favored radiation therapy as an adjunct in their treatment, with some difference of opinion as to whether biopsy should be done or complete extirpation be attempted.

Because the tumor cells may spread through the subarachnoid pathways and implant themselves in any portion of the cerebrospinal axis, roentgen therapy was given through four skull portals and to posterior areas over the spinal cord. In one case in which the cerebellum received a tumor dose of 5,763 r no tumor cells were found in this region at autopsy but the spinal cord, treated with a tumor dose of 4,261 r, showed living neoplastic cells. Unfortunately, the time intervals between the five series of treatments were too long in this instance to have these total tumor doses mean anything. Nevertheless, the first few series, with tumor doses over 3,000 r, indicate that such dosage is inadequate for even the so-called radiosensitive medulloblastoma group.

Concerning radiation technic, we have noticed a tendency to employ two posterior cerebellar portals of small size and spinal portals, with no radiation centered over the greater portion of the cerebrum and its subarachnoid spaces. We feel that the entire cerebrospinal axis should be irradiated.

The 10 cases followed show:

	Yr.	Mo.	Series	Tumor Dose	Operation
Lived	4	5	5	5,763 r	Partial removal
Lived	4	5	2	2,302 r	Partial removal
Living	2	4	2	2,601 r	Partial removal
Lived	1	8	2	2,260 r	Partial removal
Living	1	7	3	3,954 r	Partial removal
Living	1	6	1	1,626 r	Biopsy
Living	1	4	3	3,859 r	Biopsy
Lived	1	1	1	726 r	Biopsy
Living		9	1	1,626 r	Partial removal
Lived		4	1	1,476 r	Partial removal

Of the 5 patients known to be living, we can only hope for some prolongation of life in the 2 who have received tumor doses over 3,000 r. It should be noted that not one patient in this group co-operated by returning for treatments as requested. That is, not a single patient received the five series in a year, whereby it was hoped to attain adequate tumor dosage over a reasonable time.

Most investigators have found that radiation primarily affected the tumor cells and connective-tissue elements and that the blood vessels showed less effect. There was a relative increase in the stroma following irradiation.

GLIOBLASTOMA MULTIFORME

Of the 9 cases of glioblastoma multiforme, there were 5 in females and 4 in males, the ages ranging from eleven to sixty-five years. Eight cases were traced, one being studied with pre-irradiation and post-irradiation autopsy specimens. Since necrosis forms an integral part of these tumors, it was impossible to determine accurately the part played by tumor growth and that by irradiation. With a tumor dose of 3,172 r given in one series, there were still some tumor cells present, and this dose may therefore be termed inadequate. Of the 8 patients traced, only 2 are living. As will be seen by the tabulated results, radiation, in our hands, has been a failure, though at least six papers reviewed by us spoke of it with favor. The most impressive clinical work, that of Fried (22), showed 2 patients living, one for three years and one for two years and ten

months after tremendous total dosage protracted over several months. We have followed Fried's method in a modified form in one recent case and the patient is still living. To quote Frazier (21), "the cells and stroma exhibit a more homogeneous reaction to irradiation but show a higher degree of resistance." The terms "restraining influence" and "favorable clinical response" used by others are not borne out by our experience.

	Yr.	Mo.	Tumor Dose	Location
Lived	1	3	924 r	Right motor cortex
Lived	1	1	1,045 r	Left parietal lobe
Living		11	1,672 r	Right cerebrum
Lived		5	2,320 r	Right cerebrum
Living		4	3,596 r	Right temporal lobe
Lived		3	3,172 r	Both parietal lobes
Lived		2	1,804 r	Posterior supratentorial
Lived		1	2,116 r	Right fronto-parietal (biopsy only)

PONTINE TUMORS

Pontine tumors constituted a most unsatisfactory group, first, because there was no operative and microscopic verification; second, only one of the 10 patients cooperated by returning for planned therapy; finally, 6 of the 10 died in very short order. There were 5 males and 5 females from three to forty-eight years of age.

The lack of response to irradiation would bear out the fact that many of these tumors are actually in the glioblastoma multiforme group, while a few represent spongioblastoma polare or resistant astrocytomas. The 2 patients who have lived longest received such low tumor dosage that we are inclined to believe that the clinical diagnosis was incorrect. Only two hold our interest, one receiving a tumor dose over 5,000 r and a second treated with 400-kv. apparatus. They are the fifth and tenth of the cases listed below.

	Age		Yr.	Mo.	Tumor Dose	Series
Female	21	Living	2	10	1,254 r	1
Male	28	Living	1	7	1,446 r	1
Female	7	Lived	1	3	1,031 r	1
Male	48	Lived		7	1,446 r	1
Male	10	Living		7	5,211 r	3
Female	4	Lived		7	1,441 r	1
Female	6	Lived		3	1,157 r	1
Female	6	Lived		3	967 r	1
Female	3	Lived		3	150 r	1
Male	22	Living		1	2,861 r	1

ASTROBLASTOMA

We have had 2 cases of astroblastoma and both patients are living and well. One male, aged thirty-six years, had a large lesion in the left parietal region which was partly extirpated; he is alive four years and six months after a tumor dose of 2,000 r. A second male, aged four years, is living two years and six months after partial removal of a tumor in the third ventricle region and three series of roentgen treatments giving a tumor dose of 3,412 r. It is interesting to note that Frazier (21) and his collaborators, after studying their pooled cases, devote one sentence to this subject, as follows: "A few astroblastomas were irradiated but the number was so small that no conclusions could be drawn concerning them." We were therefore forced to follow the advice of Bailey, Sosman, and VanDessel (5) who say: "Although there is no conclusive evidence from our experience that these tumors are influenced by irradiation we should think it advisable to give a course of treatments after operation because the tumors contain fairly numerous mitotic figures and are liable to recur."

ASTROCYTOMA

Five astrocytomas were treated, 3 in females and 2 in males, the age range being six to thirty-three years. One patient was untraced. The others are living and well. Three of the tumors were protoplasmic astrocytomas, and one patient in this small group is alive after four years and one month but the tumor dosage in each instance was so small that no beneficial result could be attributed to irradiation. These were all cerebral tumors and the tumor dose ranged from 392 to 1,080 r.

Two fibrillary astrocytomas were irradiated and both patients are living after four years and two months. A right frontal tumor received a dose of 2,194 r and a cerebellar tumor 2,303 r. We can draw no final conclusions from our small number of cases. Deery (14) found microscopic changes in two of three fibrillary astrocytomas following irradiation, which he at-

tributed to the roentgen rays. We have not found evidence sufficient to cause us to refuse treatment when these tumors have been incompletely removed, though we are aware of the many statements in the literature against the use of irradiation in the fibrillary astrocytomas. At least six papers reviewed favored radiation in the protoplasmic astrocytoma group.

EPENDYMOMA

Before discussing our small group of 4 ependymomas, we would again emphasize that it is assumed from the operative notes that the tumors were incompletely removed. The Neurosurgical Service is given full credit for referring these cases for irradiation. All 4 patients are living and well. Only 2, however, had sufficient tumor dosage and have lived sufficiently long to be of significance in this connection. One female, aged four, with a cerebellar lesion received five series of treatments in a one-year period, with a tumor dose of 7,548 r; she is living five years and three months from the date of operation. A male, aged twenty-five years, with a tumor involving the right lateral ventricle, running through the foramen of Monro into the third ventricle, received a tumor dose of 3,942 r in three series and 2,118 r to the spinal canal and is living four years and nine months following operation. The unconventional irradiation to the entire cerebrospinal axis was based on the extent of the tumor, its location, and the fear of implantation metastases. Weaver, Dercum, and Spiller (38) reported such occurrences between 1898 and 1907 and more recently Kernohan has brought up the subject. We realize the wide divergence of opinion concerning the value of irradiation in these tumors. Two important authorities discouraged therapy but six equally important publications were favorable to it. We admit that these lesions are usually relatively benign but question the wisdom of assuming that tumors incompletely removed are or will remain nonmalignant.

CRANIOPHARYNGIOMA

Eight craniopharyngiomas were treated; 7 of the patients are living but we realize that these figures mean nothing. We are satisfied to follow Frazier (20) and give these patients any benefit which might obtain from such efforts in view of the inability of the surgeons to remove the growth completely. Upon purely hypothetical reasoning that radiation might destroy or inactivate the epithelial cells lining the cyst wall following the evacuation of the cyst, Frazier collected a group of children under observation in whom by this combination of treatment the symptoms appeared to be arrested. Our 8 patients included 5 males and 3 females, from four to thirty-nine years in age. One died in one and one-half years and 7 are living from four years and five months to only three months. Only 2, however, have co-operated and received more than one series with tumor dosage above 3,500 r, so that we have no data upon which to draw conclusions. We cannot see how the fatalistic attitude expressed in most papers will ever lead to sufficient trial of radiation to yield the data needed to determine its efficacy in this group.

PITUITARY ADENOMA

Our series of pituitary adenomas is too small to add anything of value. The small number of cases, 8 in all, treated in six years is indicative of the conservative nature of our referring neurosurgeons in relation to other tumors. One patient with a chromophile adenoma is living eleven years; 3 with chromophobe adenomas have lived for seven years, three and a half years, and one and a quarter years. We are inclined to agree with Meredith (27), who believes that if vision is poor one should not wait for the effects of roentgen therapy but operate. The chromophile tumors are more sensitive than those of the chromophobe type, but in both irradiation can well be reserved for use following operation. Roentgen therapy without operation is limited to those who refuse surgery. Sosman has stated that with visual impair-

ment of over a year's duration the chances of recovery are poor with either x-ray or surgery.

UNCLASSIFIED TUMORS

Ten brain tumors were unclassified and unverified microscopically, and 7 of the patients have been traced. Only one cooperated, receiving five series of treatments in one year. He presents calcified deposits in the left parietal region fairly typical of an oligodendroglioma, which would prove to be radioresistant, with a long natural life history. His tumor dose was 8,617 r. Two patients with cerebellar tumors, receiving doses of 3,200 r, lived three and a quarter years each; from the operative notes their tumors were undoubtedly medulloblastomas. One patient with a tumor in the pineal region is living five years and three months; lack of microscopic data in this case is a distinct disappointment. A right frontal tumor receiving four series of treatments and a tumor dose of 5,935 r was probably a cerebral astrocytoma; the patient lived one year. In two other cases, the tumor dosage, clinical data, and length of life were such that they are of no significance.

SPONGIOBLASTOMA POLARE

We had only one example of spongioblastoma polare, in a boy aged fourteen years who had partial excision of an occipital lobe and a tumor dose of 1,425 r. He lived only ten months following operation, and these months were very sad ones indeed. We found only one favorable report in the literature and two very authentic opinions unfavorable to irradiation, with which our experience is in agreement.

HEMANGIOBLASTOMA

One male aged twenty-four years had a cerebellar hemangioblastoma incompletely removed; he received a tumor dose of 1,626 r, and lived a little more than one year. We have read of a favorable case but it would appear that surgery rather than radiology deserved the credit. A few other favorable observations have been found but no remarkable evidence was uncovered either way.

HEMANGIOMA

Five hemangiomas were treated. Four of the patients were traced and 2 are living one year and one month each, one with a cerebral and one with a cerebellar lesion. Two patients with cerebral lesions lived less than one year. Our results have been unimpressive, but so also has been the size of our tumor doses. We have found a few reports favorable to irradiation.

MENINGIOMA

It is not customary for us to treat tumors of the meningioma group. There are a few reports in the literature favorable to irradiation of tumors of the fibroblastic type. Meredith has recently reported a case of meningioma which microscopically appeared to be very benign but which recurred in a very malignant manner. It would therefore appear wise, in our opinion, when the tumor has not been completely removed to administer roentgen therapy. Actually, our single case was reported by Dr. A. C. Broders, Professor of Surgical Pathology, as a "dural endothelioma resembling squamous epithelial cells." The lesion was cerebellar and incompletely removed. A tumor dose of 2,758 r was given and the patient died four years and four months following operation. In retrospect, we would have given more adequate tumor dosage, and we most definitely would treat incompletely removed meningiomas, notwithstanding advice to the contrary in the literature.

SARCOMA

We have had only one case of sarcoma, apparently of meningeal origin, in the right frontal region. A tumor dose of 2,149 r was given in a single series but only a few months have elapsed. We would advocate treatment of these tumors, as of incompletely removed meningiomas. The literature on the subject is completely inadequate.

RETICULUM-CELL SARCOMA

Two cerebellar lesions resembling medulloblastoma except for the microscopic picture with Foot's silver stain, which showed reticulum-cell sarcoma, received moderate tumor dosage, 1,647 r each. One patient lived ten months, while the other is untraced. From the standpoint of prognosis, the distinction from medulloblastoma, as pointed out by Bailey (6), is helpful, as these sarcomas are more resistant to radiation. This case appears to confirm Bailey's view.

METASTATIC TUMORS

Four metastatic tumors were treated and all the patients are dead. One of this series was a sarcoma manifesting itself three years after operation for retroperitoneal sarcoma. A second was an anaplastic carcinoma primary in the urethra. The primary growth was discovered more than a year after biopsy of the brain tumor and considerable therapy had been administered as the pathologic report on the brain biopsy had been equivocal. A third patient had a primary carcinoma of the lung and a fourth carcinoma of the breast. We are not advocates of roentgen therapy for metastatic tumors of the brain. If, however, no primary site is found and the pathological diagnosis is equivocal, we should not hesitate to repeat the above experience until more adequate diagnosis were forthcoming.

SPINAL CORD TUMORS

We have had a total of 16 spinal cord tumors, as listed below. We have given the type of tumor where possible, the level at which the roentgen ray beam was centered, the total tumor dose, the number of series of treatments, and the length of life following operation when known. Actually the last 7 cases, listed by us as "unclassified," will be found to have been diagnosed clinically and at operation as intramedullary glioma, but in view of our inability to obtain microscopic verification, either because biopsy was not done or the specimen taken was too small or the diagnosis equivocal, we prefer to list them as unclassified.

The literature is strangely silent in respect to any constructive suggestions on the technic or value of roentgen therapy here. Yet these are the cases which most need help—patients with normal brains, functioning perfectly, but with partial or complete paralysis at some spinal level and below and further trouble impending, while the surgeon stands aside and leaves the problem to the radiologist for whatever he can make of it. All of the 7 patients with unclassified tumors are living and in 6 of these the tumor doses were high and adequate. Of the total of 16 patients, 10 are living, 3 are untraced, and 3 are dead.

If we can do nothing else, as a result of the study of our failures in tumors of the brain, than apply what little knowledge we gain to the treatment of these unfortunate patients, our work will not have been in vain. To give them years or even months of comfort and occasionally useful life is worthy of our best efforts.

Very briefly, we may say that we favor 2 narrow (8 cm.), sufficiently long (usually 20 cm.) portals, posterior oblique, on each side of the spinal canal, at an angle to the center of the canal of 30 to 45 degrees, the fields being carried well above and below the site of the tumor. We use the heaviest practical filters available, usually 2 mm. copper and 1 mm. aluminum, with 200 kv. at 50 cm., doses of 100 to 250 r in air up to a total of 1,200 to 2,000 r in air to each portal in any one series. We never exceed a first degree skin reaction, preferring to repeat the series in six weeks and again at three-month intervals, as many as nine times. We have used anterior portals when the skin reaction posteriorly has been severe, or when an operative wound or the use of chemicals has made the posterior areas unsuitable at the time of treament. The depth dose, however, is not at all satisfactory with such a modification.

Details of the 16 tumors treated are as follows:

Tumor	Level	Tumor Dose	Series		Yr.	Mo.	Remarks
Hemangioma	12D	6,454 r	6	Living	4	0	
Hemangioma	3L	3,266 r	2	Living		6	
Hemangioma	11D	2,872 r	1	Living		4	Poor response
Hemangioma	9D	1,413 r	1	Untraced			
Glioblastoma m.	4C	3,530 r	2	Lived	3	3	
Glioblastoma m.	2C	1,442 r	1	Untraced			
Medulloblastoma	2C	242 r	1	Died		0	No brain lesion
Metastatic	5L	1,915 r	1	Lived		8	
Metastatic	11D	1,197 r	1	Untraced			Biopsy questionable
Unclassified	2D	7,571 r	5	Living	4	1	
Unclassified	12D	6,551 r	6	Living	3	2	
Unclassified	6D	15,584 r	9	Living	2	6	2-year period not well
Unclassified	1D	2,849 r	2	Living	1	10	
Unclassified	6D	11,057 r	6	Living	1	6	
Unclassified	5D	4,557 r	2	Living	1	0	
Unclassified	12D	1,436 r	1	Living		9	

Grant (24) has mentioned the observation of a wise and experienced radiologist, who said: "A fair test of the efficiency of postoperative roentgen treatment can be made only after all improvement following operation and decompression has ceased and definite symptoms of a recurrence of the tumor are appearing—if roentgen therapy checks the progress of the symptoms and produces improvement, then and only then can it be said that the therapy is effective." Applying this dictum to a case of tumor of the cervical spinal cord in our series, which showed improvement for three years and seven months, after which symptoms returned, we may state that extensive roentgen therapy checked the progress and relieved the symptoms. The patient is now living and well, working daily, after four years and one month.

CONCLUSION

Of 100 patients with tumors of the brain or spinal cord treated by irradiation, and surgery in most cases, 34 died, 16 were untraced, and 50 are still living. Four necropsies were performed.

Of the 100 patients, only 7 co-operated fully and received roentgen therapy as planned for them. These 7 patients are all living.

A further study of our records shows improvement or prolongation of life even in those patients who met us half way in this respect.

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Malignant Disease of the Rectum and Rectosigmoid Treated with Radium[1]

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IT IS OUR impression that treatment of polyps and polypoid malignant disease of the rectum is an ever-widening field for the radiologist. It is already a major field and we believe from past experience (1) that aggressive preoperative and planned postoperative treatment offer much promise for the future. Treatment of this condition demands co-operation of the patient, general practitioner, surgeon, proctologist, and radiologist.

The proper treatment of carcinoma of the rectum is of major importance if the high incidence of this disease is considered. Teperson (5) stated recently, after a study of records of several thousand patients who received treatment, that 5 per cent of all malignant lesions of the body occur in the rectum and colon and that the majority of these lesions are within reach of the examining finger. Buie (3) reported that in ten years at the Mayo Clinic a positive diagnosis of malignant rectal lesions was made in 2,723 cases at proctologic examination. It is known that in this serious disease prognosis is hopeless without aggressive treatment. If left untreated rectal carcinoma is attended by extreme pain, hemorrhage, foul rectal discharge, and total disability. Extension to neighboring pelvic organs, frequently with associated development of fistulas and distant metastasis to vital organs, usually occurs in cases in which treatment is not given.

The early diagnosis and treatment of polyps of the rectum should reduce the incidence of carcinoma of the rectum. Fitzgibbon and Rankin (4) studied these lesions and grouped them according to structural variations, as follows: Group 1 consists of the nodular, pedunculated tumors in which the epithelium remains normal. Group 2 consists of pedunculated or sessile tumors varying greatly in shape and size, in which the epithelium inevitably undergoes malignant change. This is the largest group. No sharp line of separation is seen between these lesions and those of group 3. The latter may attain the size of a split pea; the elementary epithelium proliferates so rapidly that morphologically it cannot be distinguished from outright carcinomatous change. In brief, the lesions in group 1 are benign; the lesions in group 2 tend inevitably to undergo malignant change, and those in group 3 are immediate precancerous lesions. The therapeutic radiologist must be prepared to recognize the gross appearance of polyps and polypoid lesions occurring alone or associated with the characteristic malignant neoplasm.

DETERMINATION OF TYPE OF TREATMENT

Before outlining the technic employed in radiologic treatment of rectal carcinomas, it is well to consider the special difficulties encountered. These are as follows:

1. The disease is advanced at the time of diagnosis. Many surgeons consider the lesion inoperable in about 65 per cent of cases in which the condition is present.

2. The average age of the patient in most large series of cases is about fifty-five years. It is known that relatively elderly persons with other degenerative diseases are the ones who usually have this lesion.

3. The involved region is tender and painful and extremely tedious to treat.

4. The field of treatment cannot be absolutely sterilized nor can it be put to rest during treatment.

5. Lesions high in the rectum are not accessible in their entirety to examination and treatment.

To consider treatment of disease in any

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location, it is best first to classify the condition. The simplest classification of rectal carcinomas, according to their gross appearance, is: (1) polyps or polypoid protuberant lesions; these are often multiple; (2) infiltrating or excavating lesions; these usually involve the muscular coat and invade the lymph nodes early in the course of the disease; (3) annular lesions; these usually denote extension of the disease and mean that diagnosis has not been made until the condition has progressed considerably; (4) perirectal lesions; in these the malignant growth is often primary in a neighboring or distant organ and produces rectal stricture. The growth may originate, for example, in an ovary, the prostate gland, or bladder and eventually cause perforation of the bowel.

These lesions may be classified also according to location of the growth in the bowel. This is important, as it often determines the proper method of treatment. This classification is as follows: (1) anorectal lesions, including about 7 per cent of all rectal carcinomas; (2) lesions low in the rectum; (3) lesions in the mid-rectum; (4) lesions high in the rectum; (5) lesions in the rectosigmoid, this last group also comprising 7 per cent of all rectal carcinomas. Buie found that in a large series of cases, 60 per cent of the lesions occurred in the upper part of the rectum and in the rectosigmoid.

These lesions may also be classified according to microscopic findings. At the time of proctoscopic examination, biopsy is carried out. From the reports of the pathologists in a large series of cases, Buie found that 94 per cent of the lesions were adenocarcinomas, 3 per cent were squamous-cell epitheliomas, with 1 per cent each of mucoid adenocarcinomas, melanoepitheliomas, and lymphosarcomas. The microscopic grading of these lesions is of great importance. In this same group, 45 per cent of the lesions were of grade 1; 39 per cent, grade 2; 15 per cent, grade 3; 1 per cent, grade 4 (Broders).

The prognostic significance of grading was brought out by Broders (2), who studied 560 cases of rectal carcinoma and found definite metastasis in 260. The percentage of cases in which metastasis was present increased directly with the grade of the lesion, ranging from 26 per cent of cases in which the lesions were grade 1 to 64 per cent of cases in which they were grade 4.

We can decide from these studies whether the condition is operable. The main factors which the proctologist, surgeon, and radiologist have to consider in deciding operability are the size and extent of the lesion, its location, the presence or absence of fixation, obstruction, metastasis, microscopic grading, and associated serious systemic diseases. Of these, fixation of the growth is probably one of the main criteria in deciding whether a lesion is operable. Another main consideration is the presence or absence of metastasis. This usually is determined by exploration at the time of colostomy.

TREATMENT

If carcinoma of the rectum has been diagnosed in a stage in which complete extirpation is feasible, treatment is chiefly surgical. It has been found, however, by many surgeons that about 65 per cent of the lesions are inoperable. The rôle of radium therapy, therefore, is important. Even in hopelessly advanced cases irradiation accomplishes invaluable palliation, while in some inoperable cases sufficient shrinkage of the growth may occur to make surgical intervention possible. As this study is devoted to the technic of radium treatment, we will not go into the question of the type of surgical procedure but will emphasize the importance of co-operation between surgeons and radiologists to obtain the best result.

It is only in comparatively recent years that treatment of rectal carcinoma with radium has commenced to achieve satisfying results. The technic in earlier years was based on the more familiar methods of treatment of carcinoma of the cervix- employing tubes with moderate filtration containing salts of radium or radon; these were placed in the center of the lumen of

annular lesions. In many cases, if the growth was confined to one wall, radium was attached to hard rubber or metal applicators, which were placed digitally and fastened to the buttock by means of metal stems. The back of the applicator was usually leaded heavily to protect the normal mucosa. This type of applicator remained for many hours in the region of the anal sphincter. It caused much discomfort and could not be securely maintained in the correct position for the time of treatment. Glass radon seeds were often buried in rectal growths with resultant necrosis and pain from the irradiation by the beta rays. Metal needles which contained salts of radium were employed, but the filtration was often of poor quality. In the early years roentgen rays of moderate voltage were generally employed. The results of these older methods were not too encouraging and were similar to the effects of early treatment of cancers in other regions of the body such as the mouth, tongue, and pharynx.

Present Technic: In general, carcinoma of the rectum is treated with radium for either cure or palliation. Although some type of surgical intervention as a direct attack on the primary lesion is the preferred procedure, we have found it helped to classify the treatment with radium in reference to surgical procedures as follows: (1) preoperative treatment, (2) postoperative treatment, (3) non-operative treatment, and (4) treatment at the time of operation.

Although this classification seems self-explanatory, the following definitions are for clarification. Treatment with radium in any case in which surgical intervention is intended in the future is classified as preoperative treatment. Radium application after surgical intervention, regardless of the length of the interval, is classified as postoperative treatment. Treatment in inoperable cases is classified as non-operative treatment. Treatment immediately on completion of the surgical procedure is classified as treatment at the time of operation.

Careful study of the patient and lesion is needed before the type of radium treatment is determined. Accessibility of the lesion is of primary importance. If the growth is operable—in other words, if it is not too large, is not fixed, and is not too high in the rectosigmoid to be visualized completely—aggressive and radical treatment with radium is indicated as a preoperative measure. This radical treatment frequently includes the "buried radium" technic, which always entails a certain risk, though the needles or seeds used at present have better filtration for excluding beta radiation than those used formerly. Shrinkage of the growth is obtained without the irritation and necrosis seen when the glass seeds or needles with poor filtration of former days were used. The "buried" technic is employed only when the lesion is fairly small and when it can be well visualized; it usually is employed only when the posterior or lateral wall of the rectum is involved. Most radiologists consider that lesions on the anterior wall should not be treated in this way because of the proximity of the prostate gland and bladder and possible irritation of, or spread of infection to, these tissues.

All patients are hospitalized for applications of radium; in cases in which the "buried radium" technic is employed preparation is necessary and a brief convalescent stay is desirable. If necessary, mild saline cathartics are given. A low-residue or non-residue diet is given in cases in which the buried radium technic is employed and also in cases in which some type of electric coagulation is used. For the average non-operative treatment in the patient who does not have a colonic stoma, enemas only are employed. These patients usually are on a general diet. Patients who have a colonic stoma may require a special diet. The lower loop of the stoma may need saline irrigations as a cleansing measure.

The lesion is prepared as well as possible by thorough cleansing of the bowel with green soap, water, and cotton applicators. The placement of sufficient gauze packing

well above the lesion or field of treatment will prevent gross soiling. Merthiolate, metaphen, or some other antiseptic agent is used before the needles are introduced. If the lesion extends into the lumen, preliminary light coagulation of the surface of the malignant ulcer is frequently of great help in prevention of bleeding caused by insertion of the needles or seeds and provides a more sterile field for the minute punctures necessary. Gold seeds that have a wall thickness of 0.3 mm. or platinum needles that have a wall thickness of 0.4 mm. are placed, one unit to each cubic centimeter of involved tissue, up to the edge of the lesion. The needles are left in place for at least forty-eight hours. The seeds or needles contain either 1 mc. of radon or 1 mg. of radium sulfate (element).

For favorable lesions such as we have been discussing, contact treatment may be preferred to treatment with buried radium, avoiding risk of infection or bleeding. For contact treatment two tubes containing approximately equal amounts of radon filtered through 0.5 mm. of silver and 1 mm. of brass are enclosed in 2 mm. of soft rubber and strapped together to form a small plaque; this is placed directly against the lesion. Several applications may be necessary, probably one a day, to cover the entire growth or base of the lesion adequately. Radiologists who are treating rectal carcinoma should be fairly well trained or experienced in proctology. A proctoscope with a direct light is used; we have found one about 16 cm. long and 70 mm. in circumference useful. Gauze packing in a continuous strip half an inch wide, which has been soaked in an aqueous solution of metaphen or other non-irritating antiseptic, is used. The packing is placed well above the lesion so that the radium applicator does not slip up beyond the field; the radium applicator is inserted and the packing is continued with a short, metal, pronged packer for the purpose of protecting the opposite normal wall and for holding the applicator rigidly in place. As much gauze as possible is packed above, at the level of, and below the applicator, but packing of the region of the sphincter is avoided if possible. The end of the packing and the string attached to the radium applicator are fastened to the buttock with adhesive tape.

TABLE I: DOSAGES IN CONTACT TREATMENT OF CARCINOMA OF THE RECTUM*

Millicurie Hours per Sq. Cm.	Millicurie Hours	
	1 tube 0.75 by 2.5 cm. 1.875 sq. cm.	2 tubes 1.5 by 2.5 cm. 3.75 sq. cm.
40	75.2	150.0
50	93.7	187.5
60	112.5	225.0
70	131.2	262.5
80	150.0	300.0
90	168.7	337.5
100	187.5	375.0

* Filtration: 2 mm. of rubber, 1 mm. of brass, 0.5 mm. of silver.

The dosage can be decided after the radium and packing are in place and depends to some extent on how well the opposite wall is packed away from the radium. The usual dosage for patients who have not undergone colostomy is from 60 to 100 mc. or mg. hours per square centimeter of diseased surface tissue covered. Table I shows the number of millicurie hours given with these plaque-like applicators—either one tube or two tubes arranged parallel to each other—to obtain a dosage of from 40 to 100 mc. hours per square centimeter. Ordinarily we use a plaque containing two tubes, either 50 mg. of radium salt per tube or about 50 mc. of radon per tube. With tubes of this strength, the radium must remain in place three to four hours for each treatment. The total dose is heavy. The number of roentgens applied at the level of the mucous membrane or surface of the neoplasm and at various depths in the tissue is given in Table II.

In certain instances both radium and roentgen therapy are given, especially if the grade of malignancy of the lesion under consideration is 3 or 4. This type of treatment, however, is used in only a small percentage of cases. It is our belief as a result of experience, that as the normal rectal mucosa is sensitive to irradiation, the best type of treatment consists of intense

TABLE II: RADIUM THERAPY IN CARCINOMA OF THE RECTUM, DOSAGE IN ROENTGENS*

Depth in Tissue, Cm.	Total dose in Roentgens					
	Single tube, mc. hr.			2 tubes parallel, mc. hr.		
	500	600	700	300	337.5	375
0	11,800	14,160	16,520	5,550	6,245	6,940
0.5	3,680	4,416	5,152	2,130	2,395	2,660
1.0	1,730	2,076	2,422	1,005	1,130	1,256
1.5	995	1,194	1,393	570	641	712
2.0	640	768	896	381	428	476
2.5	445	534	623	267	300	334
3.0	330	396	462	198	223	248
3.5	255	306	357	153	172	191
4.0	200	240	280	120	135	150
4.5	160	192	224	96	108	120
5.0	135	162	189	81	91	101

* Filtration: 0.5 mm. of silver, 1 mm. of brass, and 2 mm. of rubber (tubes in contact with tissue).

gamma radiation applied accurately to the malignant tissue, with ample protection of all normal surrounding bowel wall.

In the ordinary so-called preoperative cases, in which fairly small, accessible, and movable lesions are present, contact treatment or treatment with buried radium, if feasible, is employed. Such treatment requires about seven to ten days in the average case and usually is given daily until the entire lesion has been well covered. The interval between treatment with radium and surgical intervention should be sufficiently long to permit the major response of the tissue to have passed away. This interval is usually two or three months or more. Much depends on the intensity of treatment and adequate healing of the treated tissues.

Another method of treatment for small favorable lesions consists of fulguration along with immediate treatment with radium. Buie has had considerable experience with this type of treatment. The monopolar type of Oudin current is used to burn or char the tissues. Lesions so treated are chiefly polypoid growths situated on the posterior rectal wall below the reflection of the pelvic peritoneum. Immediately at the conclusion of fulguration, which may take a few days to carry out, radium is applied in the form of contact treatment. The radium treatment minimizes the hemorrhage occasionally associated with fulguration and serves to kill residual cancer cells. This combination of fulguration and radium is equally applicable to non-malignant polyps and polypoid lesions. If untreated, these tumors tend to become malignant.

For women additional irradiation is afforded if vaginal packs are employed, once each day for two or three days. Fifty milligrams of radium sulfate are employed, filtered through 1.5 mm. of monel metal, 2 mm. of lead, and 1 cm. of rubber. Gauze is used to maintain the applicator in place. Duration of treatment is fourteen hours to a field. One to three or more vaginal fields are treated.

For anorectal lesions use is made of a hard rubber (rectal dilator) applicator, which contains three radon tubes in tandem formation. The applicator is strapped to the anal canal. If three tubes, each of which contains 50 mc. of radon, are used, treatment is ordinarily given for three hours.

Invaluable palliation may usually be obtained in inoperable lesions by the use of conservative, although fairly heavy, treatment. These lesions may be extensive or they may be small fixed growths which usually have metastasized to vital organs. The conservative treatment employed consists of contact irradiation. This carries no risk, but the dosage is sufficient to cause a decided shrinkage of the growth in practically all cases, and to relieve pain and distressing rectal discharges. Several weeks may be needed before relief of pain and cessation of discharge occur and increased distress may be present for the first few weeks after completion of treatment. Suppositories of belladonna and opium are usually prescribed for this initial period of reaction. Warm packs applied to the anal region, Sitz baths, etc., are also advised.

Many of these inoperable lesions are annular. In selected cases, colostomy has been carried out. Radium applicators giving 500 to 700 mg. hours per tube, single or tandem, are placed in the lumen of the bowel. Heavy filtration with 2 mm. of lead, in addition to the primary brass

and silver filtration, is employed. If necrosis is a complicating factor, applications usually of 50 mg. for ten to twelve hours are made along the length of the stricture. This dosage without lead filtration is heavy and produces a type of internal colostomy by keeping the lumen of the bowel open. Often in these extensive annular lesions, colostomy to relieve obstruction may be deferred for a considerable time, frequently for years. These patients may require special instructions or care after treatment. For example, mild saline cathartics, low saline irrigations, or enemas may be necessary at times. They are further instructed in the use of some type of food mill or preparation of food for a low-residue or non-residue diet. Palatability and appearance of the food may be improved by adding prepared vegetables to various kinds of soups or soup stock; gelatin may be added for solidification, thus affording variations in serving.

Technic can be outlined only with great difficulty, for the extreme variation of the malignant process to be treated must be considered. The extent and location of the growth influence the type of applicator employed. Every effort is made to individualize the treatment as well as keep in mind the probable result to be obtained.

RESULTS

In this short article we are considering chiefly the technic of treatment with radium. As a rule, results have been satisfying when the advanced type of lesion treated is considered. The radiologist will always have a large field in palliative treatment in extensive cases, though, as mentioned before, the greatest promise for the future lies in preoperative and planned postoperative treatment of favorable lesions. In 1934 we published a review (1) of the data concerning 500 patients treated with radium at the Mayo Clinic from 1915 to 1931, inclusive. Of this group, 193 (39 per cent) survived for three years, five years, or ten or more years. The percentage increased to 45 for the smaller group of patients who received preoperative treatment.

CONCLUSIONS

The early diagnosis and treatment of polyps of the rectum should reduce the incidence of carcinoma of the rectum. Few malignant processes of the body are as difficult and tedious to treat as rectal carcinoma. The radiologist must have considerable experience in proctology. The field of treatment is limited; only palpable or visible lesions as seen through the proctoscope can be treated. It is often impossible to outline the lesion accurately or to treat beyond the flexure of the bowel, and the actual treatment is tedious for both physician and patient. The results of treatment, however, compensate for all these factors. Treatment of lesions in few sites is so successful in ameliorating such severe symptoms as attend this condition. The results vary directly with the amount of care and painstaking effort employed by the radiologist.

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Combined Irradiation and Surgery in the Treatment of Carcinoma of the Pelvic Colon[1]

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A GREAT MANY articles have appeared in the literature describing various methods of treating carcinoma of the colon and rectum, and giving statistics of the cures obtained with these methods. Generally speaking, the methods resolve themselves into three categories: (1) surgery alone, (2) irradiation alone, (3) combined irradiation and surgery.

In some instances the procedure of choice has been determined by the extent of the lesion and in others by the availability of radium or high-voltage x-ray equipment. Where all these therapeutic agents have been available, the method has depended upon the judgment of the surgeon and radiologist in the individual case, according to the location and extent of the growth.

We are not attempting to describe any unusual treatment but rather a combined method of irradiation and surgery, which we have used for many years and which, in our hands, has proved to be more satisfactory than either irradiation or surgery alone. It is essentially one of friendly teamwork on the part of the radiologist and surgeon, in which each carries out his own work according to a prearranged schedule.

METHODS OF RADIATION THERAPY

Radiation therapy is of value in all types of carcinoma of the pelvic colon. Its value may be classified under three headings: (1) In very early cases, and in some which are more advanced, it may be curative. (2) It may be useful in conjunction with surgery in operable cases and in those borderline cases in which it may produce enough improvement to render them operable. (3) In inoperable cases it is an excellent palliative agent; the patient is usually improved physically and mentally and there results a definite prolongation of life over untreated cases.

Radiation therapy includes both high-voltage x-ray therapy and radium therapy. Either one or a combination of both may be used in the same case. High-voltage x-ray therapy is usually applied to the skin around the pelvis with the central ray directed toward the tumor. Multiple portals of entry are used, the number usually varying from four to six. In some cases single full erythema doses are applied daily until the series is completed. In others the divided dose technic is used. This has the advantage of securing a greater tumor dose in comparison with the skin dose. In addition the disagreeable general reactions are not as marked as when larger single doses are given. In some cases high-voltage x-ray therapy can be applied directly to the tumor through a proctoscope but the number of such cases is of necessity limited.

Radium may be used in the form of a radium pack for external irradiation, but this can be done by relatively few persons owing to lack of availability of the required supply of radium. A second method of using radium is the implantation of gold-filtered radon seeds directly into the tumor. This is accomplished by direct vision through a proctoscope by means of long trocar needles. The strength of the seeds varies from 0.5 to 3 millicuries each, the choice depending upon the size of the tumor and its radiosensitivity. Needles containing radium element may also be used in this type of interstitial treatment. A third method is the surface application of radium to the tumor. This is accomplished by inserting an applicator containing radium tubes into the rectum in contact with the tumor. This has the disadvan-

[1] From the Departments of Roentgenology and Gynecology, Henry Ford Hospital. Read before the Radiological Society of North America at the Twenty-sixth Annual Meeting, Cleveland, Ohio, Dec. 2–6, 1940.

tage of producing extensive surface necrosis and a relatively inadequate dose to the base of the tumor. The results obtained by this method have been discouraging, but it is a valuable aid in combination with other methods.

EXTIRPATION OF CARCINOMA OF THE PELVIC COLON

Conformity to the fundamental principle of radical removal of cancer is particularly important in dealing with malignant growth in the pelvic colon. In this region the incidence of metastases is higher than in other portions of the colon. Restoration of function of the bowel after resection of the growth is less mandatory but is greatly appreciated by the patient. While irradiation may diminish the size of a cancer of the pelvic colon and increase the operability, excision is essential whenever possible.

The operative procedure requires considerable individualization, but we have learned that a one-stage abdominoperineal or combined anterior and posterior resection is applicable in a great majority of cases. This method, used since 1924, has resulted in approximately 60 per cent survivals for five years or longer, this percentage being based on all operated cases, including palliative operations. By a more careful selection of cases, the survival rate could be improved. The operability in our series was 95 per cent.

The operation, as previously described by one of us (J. P. P.) (12), consists of laparotomy and posterior or perineal resection. The laparotomy is performed first, permitting preliminary inspection of the location and extent of the growth and a survey of the abdominal viscera. According to generally accepted procedures, the inferior mesenteric vessels are sectioned. The pelvic colon is mobilized to a level below the tip of the coccyx. By block dissection, the pelvic colon, mesentery, and if necessary the uterus with the adnexa, are freed. (Preliminary irradiation facilitates the process of mobilization.) The whole mass is tucked into the pelvic cavity and the peritoneum closed over it. If the mass is too large for the cavity, the closure of the peritoneum and abdominal incision may be postponed until the posterior resection is completed. During the abdominal operation, consideration of the location and extent of the growth permits the operator to estimate the desirability of electing to do a perineal or posterior resection.

The choice between a perineal and posterior resection depends upon the proximity of the growth to the anus. For perineal resection the lithotomy position is preferred. The Sims or lateral position provides the best exposure for the posterior resection.

It is in the posterior resection that our operation differs from others described. An incision is made in the mid-line from the tip of the coccyx to a point near the anus. By adhering to the mid-line one encounters little bleeding, and the nerves to the levator are not injured. Injury to the coccyx or its periosteum is carefully avoided. The incision is extended inward to meet the dissection from above. The previously mobilized colon is delivered through the incision. By inspection of the loop of bowel exposed, the level of resection can be chosen. The node-bearing mesentery above the growth and a reasonable margin of bowel below the growth are removed. In this manner as much as 22 inches of bowel have been excised. The cut ends of the bowel are anastomosed by interrupted catgut sutures. The resection and anastomosis being performed outside the body, the pelvic cavity is not soiled by the intestinal contents. When the anastomosis is returned to the pelvic cavity there is slight contamination of the tissues, but with the incision being left open a free vent is provided. A drain is placed in the pelvis for a few hours. Fecal contents drain through the incision after a few days but the infection remains localized. The incision closes spontaneously within a few weeks.

The posterior resection is preferred because it preserves the continuity of the bowel. The stigma of a perineal or abdominal colostomy is avoided.

COMBINED METHOD

Our method of combined irradiation and surgery consists of the daily application of full erythema doses around the pelvis through 4 portals of entry. The following factors are used: 200 kv.; 25 ma.; 50 cm. F.S.D.; 0.5 mm. Cu + 1.0 mm. Al filtration; 720 r units.

The patient is then carefully observed until the optimum time for operation, when complete resection is done by one of the methods described above. The interval between irradiation and operation usually varies from four to six weeks. The time for operation is based upon the general condition of the patient and the state of the local tissues.

Preoperative irradiation has been condemned by some surgeons on the basis that it increases the hazard of operation, but our experience leads us to believe that the operative risk is reduced. We believe that the time interval between the two procedures may be the determining factor in this variation of surgical opinion. If operation is performed shortly after irradiation, during the period of engorgement and while the patient's vitality is depressed, then it is conceivable that the risk is greater. If, however, the operation is postponed until the patient's physical condition has reacted favorably, the risk is diminished.

CLINICAL OBSERVATIONS AFTER IRRADIATION

Observations upon patients subjected to preoperative radiation therapy show that both undesirable and desirable local and general reactions follow its use. The undesirable reactions are inconsequential, however, compared to the beneficial results.

The undesirable immediate general reactions are lassitude, anorexia, nausea, and vomiting. These reach their peak usually about the time of completion of the treatment series and disappear in three or four days. Locally there may be edema, swelling, and tenderness of the involved tissues.

Within a period of four to six weeks after irradiation the appetite and nutrition improve and there is a gain in weight. This is accompanied by increased vigor and a feeling of well-being. This should be anticipated and the patient warned against a feeling of false security, lest he decide that subsequent surgical treatment is unnecessary. The red blood cell count and the hemoglobin improve. The ulcer decreases in size, and the discharge lessens. In favorable cases there is increased mobility of the involved colonic segment.

The almost complete absence of peritonitis in these cases which have undergone resection of the pelvic colon following preoperative irradiation (12) suggests that a certain degree of protection against peritonitis may be conferred by the irradiation. This clinical impression has been further confirmed by experimental work on rabbits, by Altemeier and Jones (1). The animals were given preliminary irradiation and after four to six weeks, 3 c.c. of a virulent mixed culture was injected intraperitoneally. In this irradiated series 70 per cent of the animals survived. All controls, which had not been irradiated, died in from fifteen to twenty hours.

Broders, Buie, and Laird (4) in a recent article re-emphasized the preoperative prognostic value of Broders' classification of carcinomas, by which all carcinomas are divided into four groups, depending upon the degree of differentiation present as determined by microscopic study. They also call attention to the postoperative prognostic value of the Dukes (6) method of classification of carcinomas of the rectum. These are divided into three groups, the basis of classification being the degree of involvement as determined by gross examination of the postoperative specimen. The groups are designated as follows: Class A, in which only the rectal wall is involved; Class B, in which the growth extends directly into perirectal tissues but does not invade the lymphatic system; Class C, in which the growth has metastasized to the lymph nodes. A study of our five-year survivals confirms the accuracy of the preoperative and postoperative prognostic values of these classifications.

At operation the tumor was reported as fixed in 73 per cent and freely mobile in 27 per cent of our cases. Palpable lymph nodes were present at operation in 52 per cent of the patients. We feel that these are frequently the determining factors in affecting the outcome of the case.

ANALYSIS OF CASES

In going over the clinical aspects of our cases we find that the average age was fifty years. Blood was found in the stools in 89 per cent of the cases and absent in 11 per cent. The duration of symptoms previous to examination averaged eleven months. In 70 per cent of the patients pain was a complaint, but this was not always localized to the tumor area. Constipation or diarrhea was present in about two-thirds of the patients and the two were combined in about 20 per cent of the remainder. The average loss of weight was 11 pounds at the time of the first examination.

By digital examination 54 per cent of the tumors were palpated, but a number were too high to be reached by this method. Eighty-six per cent were seen proctoscopically and 5 per cent gave a negative diagnosis; in 9 per cent this examination was not done.

Practically all patients in this series received x-ray therapy in the form of a cycle around the pelvis, with 4 portals of entry as described above. The cycle was usually delivered in four to six days. The average interval between radiation therapy and operation was six weeks.

In this series 46 per cent of the patients lived more than five years, 46 per cent lived less than five years, and there was an 8 per cent postoperative mortality. If the group of patients treated by surgical excision alone is included in this series the five-year cures approximate 60 per cent. This is explained by the fact that a number of patients with very early lesions were treated by surgical excision only, while many of the cases in the irradiated series were classed as doubtful when first seen, but after irradiation responded so favorably that surgery was believed to offer an added hope of permanent cure. This method appears to raise the limit of operability in patients who otherwise would not be amenable to surgical treatment.

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DISCUSSION OF PAPERS ON RECTAL CANCER AND CANCER OF THE PELVIC COLON

L. Henry Garland, M.D. (San Francisco): In the opening paragraphs of their paper, Drs. Bowing and Fricke stress many of the fundamental facts relative to cancer of the rectum. It is to be noted that their facts deal with *rectal cancer*, and not, as the title reads, "polyps and polypoid malignant disease of the rectum and rectosigmoid."

The authors believe that if a rectal growth is operable (that is, "not too large, not fixed, and not too high to be completely seen"), *radical preoperative radium therapy* is indicated, and define this as including interstitial and contact technic. They further qualify this point by stating that the buried technic is employed only when the lesion is fairly small, when it can be well seen, and when the anterior rectal wall is not involved. Now, it seems to me that, since all the region within reach of the radium is going to be removed anyway, such irradiation is unnecessary if not actually inadvisable. It delays operation from seven to ten days, it is exacting, it may be painful, and it is expensive.

The authors' tables show that with their contact technic, the effective depth of penetration of the radium is only 1 cm. Their buried technic assures an effective depth dose of 0.5 cm. It is for these reasons that I would recommend the addition of external roentgen irradiation in all cases where irradiation treatment is contemplated—that is, in inoperable cases.

For inoperable cases, the authors recommend contact radium treatment, the dosage being decided in part after the radium and packing are in place, the usual dose varying from 60 to 100 mg.-hr. per square centimeter of diseased tissue covered. It seems to me that adequate packing away of uninvolved rectal walls is of equal importance to dosage calculation in such technic.

The words millicurie and milligram are used interchangeably in many instances. The authors state that a 1 mc. seed may be inserted or a 1 mg. needle. The seed is left in place until operative resection (*i.e.*, ten days, or 110 mg.-hr. equivalent), but the needle is left in for only two days (or 48 mg.-hr.). Are the reactions under these circumstances different?

The authors believe that radiation therapy accomplishes invaluable palliation even in hopelessly advanced cases: Will they be kind enough to give us roughly, the percentage of cases in which palliation is obtained? After twelve years of experience with external and two years with added local roentgen therapy, I must admit my own results are poor. It is also stated that in some inoperable cases the growth may shrink sufficiently so that surgery becomes possible: what percentage of cases do the authors think may be so shrunk? I have seen only two out of perhaps fifty cases treated with external roentgen irradiation undergo such drastic change.

The technic of their radium therapy has been ably described by Drs. Bowing and Fricke, but to learn it, it seems to me that one would have to look over their shoulders while they are actually doing the work. If their results in inoperable cases of rectal cancer prove to be an advance over our present ones, then such personal observation is justified.

Drs. Doub, Pratt, and Jones present some figures which are interesting in view of those given by Drs. Bowing and Fricke. In Doub's group of "pelvic colon" cases, he mentions some in which the lesion could be given direct roentgen irradiation through a proctoscope. I presume, therefore, he includes rectal as well as sigmoid cancers in his discussion. Bowing and Fricke observe that 65 per cent of their cases were inoperable; but Doub and his associates found only 5 per cent of their cases inoperable! Rankin reports that 30–50 per cent of his cases are inoperable. Dr. Doub and his associates mention that in very early cases of cancer of the pelvic colon, cure may be obtained by irradiation. I doubt it. Have the authors any figures to support their view? They believe that in inoperable cases radiation therapy is an excellent palliative agent. Will they please give us some figures to support this? I do agree, however, that even if life is not prolonged it may sometimes be made more tolerable.

The preoperative technic is interesting, but not in my opinion as effective as it might be: 720 r/air are given to one of four fields about the pelvis on each of four successive days. Will Dr. Doub please tell us how large the fields are in the average case, and the angle of the beam, if any. An interval of six weeks is then allowed before operation. In what percentage of cases is a colostomy required in this interval? Have the authors had any acute pelvic colon obstructions following such dosage? The almost complete absence of peritonitis in their irradiated cases (at subsequent operation) is of interest. Have they any comparative figures on cases treated by irradiation alone? Their five-year survival rate is given as 46 per cent. This is identical with Rankin's figure (46 per cent) but not quite as good as Gabriel's (52 per cent); both these men use purely surgical methods. Rankin's cases are labelled "clinically free of disease": Gabriel's merely "survivals." I presume that the authors' patients are clinically well, as well as surviving.

Despite these criticisms, I still advocate the judicious use of irradiation in selected instances of rectal tumor, chiefly the inoperable cases, for purposes of palliation rather than cure.

Harry H. Bowing, M.D. (*closing*): I greatly appreciate Dr. Garland's discussion. We should remember that the average patient that we get to see has an extensive malignant lesion. In a small group of cases in which there are operable lesions surgical treatment is contraindicated on account of some type of cardiac lesion, chest lesion, obesity,

or age; therefore, the five-year cure rate from the standpoint of radium therapy is very low.

From the standpoint of palliation, a lessened discharge and decreased tendency to bleed, lessened pain, and avoidance of fistula, such as vesical fistula in men, will be observed in the average case.

Operability varies. English physicians report variations as low as 20 per cent to as high as 80 per cent. I have no available figure for the Mayo Clinic; however, more than 65 per cent of the patients referred to the radium therapy service have inoperable and recurring malignant lesions. Operability is a question that I think we need not decide at this time; it should, however, be based upon the extent of the primary lesion.

The rectal obstruction of non-colostomized patients will respond to the present method of dietary care; for example, on a diet low in residue and high in calories, vitamins, and minerals, with mild saline cathartics and low enemas, it is possible to keep these patients fairly comfortable. Metastasis to the liver, as well as other degenerative diseases, may take their lives, but seldom have we had a case that needed emergency colostomy on account of obstruction. If such a case should occur, I am certain colostomy should be done as a planned procedure and not as an emergency measure.

Concerning preoperative roentgen therapy, we do not employ it as a routine procedure in the treatment of cancer of the rectum. There are many reasons for this procedure: some concern the opinion of the surgeon and others concern the opinion of the roentgen therapist, but for grade 4 lesions, which are few, everything possible should be done. Neither do we employ radium therapy as a routine preoperative measure. When applied, the method may be considered a limited treatment. The interval between treatment and operation should be at least twelve weeks and perhaps longer. Much depends on how the patient responds to treatment—on secondary infection, age, and ability to recover. Many months may be required. I do know that the interval should be sufficient so that all the good results that are to be expected from the treatment have occurred. If the surgeon attempts to operate on these lesions in the height of the reaction, he may expect trouble; this is usually in the form of edema, oozing, slow healing, secondary infection, etc.

Horace C. Jones, M.D. (*closing*): I did not mean by what I said about preoperative radiation therapy to offer it as a curative agent for cancer of the pelvic colon. It is purely a preliminary procedure and we believe that it is of value.

Although there can be found in the literature, particularly in Shedden's chapter in Livingston and Pack's book,[1] that there are a few cases—less than 1 per cent—where external radiation has controlled carcinomas of the rectum for a period of at least five years, I would not advocate this as the sole method of treatment because I think surgical extirpation is necessary.

We did not mean to convey that we make a practice of treating cancer of the pelvic colon by proctoscopic methods. We meant to say merely that it has been done.

We have never had any cases of obstruction following preoperative irradiation with four doses around the pelvis, as we have administered it, and I may say that those patients which we have reported as living are at present free of disease.

As to the survival rate of 46 per cent, we wish to call attention to the fact that operability, as has been mentioned by previous speakers, varies considerably with the surgeon who is doing the work. In most of the reports in the literature, the rate of operability is given as from about 60 to 75 per cent; in our series, the operability was 95 per cent, and we believe that this is a significant factor in our mortality rate. We believe it has materially reduced the cases treated by this method and that were later operated upon.

Howard P. Doub, M.D. (*closing*): I should like to say just a few words in reply to Dr. Garland.

I might say, to begin with, that we started to use this treatment about 1924, and that all of these patients have been operated on by Dr. Pratt, who is in charge of gynecology in the Henry Ford Hospital. None was operated on by the general surgical staff. Within the past few years, however, the general surgical department has come to see the advantages of our method and all cases are now being thus treated.

Dr. Garland asked about those curable by radiation alone. I know definitely of one case which I treated back in about 1925. This patient had a very early lesion. He went elsewhere and was operated upon but no malignant growth was found. Since the case was not followed I did not include it in this series, but I did get the report from the pathologist that there was no evidence of malignant disease and the patient was living. I believe I have another case but since I am not sure of the details I cannot discuss it.

I am sure we will be criticized because of the fact we do not employ fractionated dosage or give what may be called complete dosage. This was intentional, as we did not start out to cure cancer of the rectum by radiation only. I feel that if one does that, he cannot get the co-operation of the surgeon and will not do the best job for the patient. I believe that if a uniform or standard technic, agreed upon between the roentgenologist and the surgeon, is carried out intelligently, the cancer mortality can be lowered and that the patient can obtain considerable palliative relief. As to the percentage of palliation, I have no figures. This is in the nature of a preliminary report and it is possible that some day we may have more cases when we take into consideration the general surgical cases as well.

[1] PACK, G. T., AND LIVINGSTON, E. M. (Editors): Treatment of Cancer and Allied Diseases, New York, Paul B. Hoeber, Inc., 1940, Vol. II, pp. 1574–1583.

Achondroplasia Foetalis (Chondrodystrophia Foetalis)[1]

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ACHONDROPLASIA is defined by Lawford-Knaggs as defective evolution in the process of endochondral ossification which is evidenced at a very early period of intra-uterine life. The dystrophy may be so severe that the fetus dies. The disease leads to stunting of the bones preformed in cartilage. Bones developing in membrane are but infrequently involved.

The disease has existed for centuries, as is attested by studies of ancient statues and pictures. In the early days of elaborate royal courts, the ladies-in-waiting often purchased these dwarfs for large sums of money. Though not attractive physically, they are usually intelligent, healthy, and strong.

The disease often runs in families, showing quite definite hereditary influences. In 1912 Reschbieth and Barrington recorded the pedigrees of 80 individuals of whom 20 gave a history of the disease in two or more generations. The female seems more predisposed than the male, for of 126 cases, 70 were in females and 56 in males.

Often a diagnosis can be made by inspection, as these patients present a rather characteristic habitus. Frequently they have a large head "vertex," pug nose, and blue sclerae. The trunk is of normal length; the extremities are usually thick and short. This shortness of the extremities gives the impression that the body is unusually long, though in reality the trunk is of normal length. The body presents an appearance similar to that of the Dachshund.

Frequently the hands are deformed. The third finger is short and the hands are broad. The trident hand, or at least a semblance of it, is seen in most patients. The fingers are divided into three groups diverging at the ends.

The adult achondroplastic dwarf is usually under 4 feet in height. The face is small, the vertex of the skull large, and the facial expression that of a much older person. The chest is broad and the anterior ribs are often flared. The clavicles are straight. In profile the anterior lumbar curve seems exaggerated and the buttocks are prominent. The genital organs both of the male and female are normal. The female may become pregnant, in which case the pelvic deformity becomes of paramount importance.

Since Parrot first described this condition in 1878 and called it achondroplasia there have been many other names attached to it. Probably the most descriptive is "chondrodystrophia foetalis" which was favored by Kaufmann in his description of the disorder in 1893. In view of more common usage and understanding, however, it seems best to avoid further confusion by retaining Parrot's designation, namely, achondroplasia foetalis.

Medical literature since 1878 is replete with discussions of the osseous dystrophies, many of which have not been clearly differentiated. No attempt is being made to add anything new to that literature. It is felt, however, that two of these dystrophies most commonly confused should be clearly distinguished, namely, achondroplasia foetalis and hereditary deforming chondrodysplasia (multiple cartilaginous exostoses).

In the past many have regarded these conditions as very closely related if not the same entity. It was recently pointed out that the time of onset may be one of the best differentiating factors. Achondroplasia foetalis develops in the prenatal period and is often fatal in early infancy. Multiple cartilaginous exostoses usually

[1] Read before the Radiological Society of North America at the Twenty-Sixth Annual Meeting, Cleveland, Ohio, Dec. 2–6, 1940.

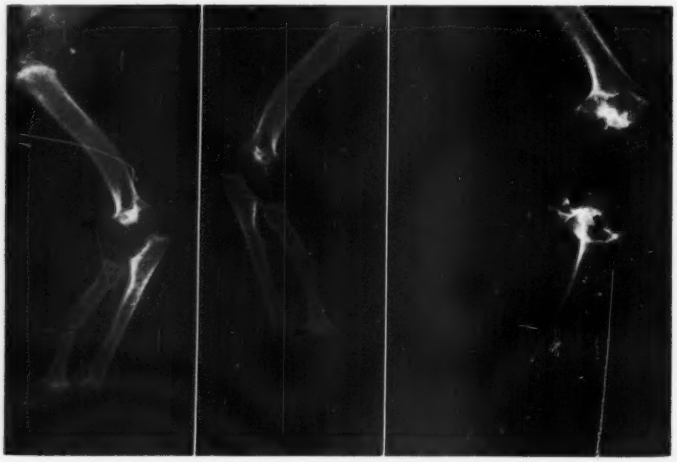
appear in childhood, having been described in patients as young as two years of age. They are rarely, if ever, fatal and the life span is seldom affected.

The next most important differentiating factor is the site of the primary lesion. In achondroplasia, the disturbance is confined to the epiphyseal cartilages while the exostoses arise from the diaphyseal side of the epiphyseal line and usually extend in the direction of muscle pull, which is away from the end of the bone.

Microscopically, the cells of the epiphyseal cartilage in achondroplasia foetalis are large, not arranged in rows, and show an undisciplined tendency to grow in all directions (Boyd). This is not true of the ordinary cartilaginous exostosis, the cells of which are usually more orderly. It must not be overlooked, of course, that there are apparently some epiphyseal disturbances in cases which are primarily characterized by exostoses and it may not always be easy to differentiate the two conditions so sharply.

The pathological findings in achondroplasia foetalis have been described many times since Parrot first established the disturbance as an entity. No attempt is being made to discuss all the changes which have been noted. A few of the diagnostic characteristics are illustrated and discussed as they appear in several cases which have been examined during the past few years.

Very few cases of achondroplasia among Negroes have been reported in the American literature. It is of special interest that four of the patients in our group are Negroes. In 1923 Lewin and Jenkinson found one case in the literature and added two of their own.



Figs. 1 and 2. Case 2: L. L. at the age of six years. Note the short upper extremities and flaring of the metaphyses; pronounced fragmentation and widening of the ends of the long bones of the lower extremity; "cuffing" produced by periosteal bone formation around the epiphyses; widening of the joint space at the knee.

CASE 1: A. L., colored, age 19, entered the hospital on Aug. 28, 1928, in early active labor. She had always been short and somewhat "deformed." She had had only the usual childhood diseases and her history revealed no evidence of familial dwarfism. Her menses had been irregular from their onset at the age of fourteen. This was her first pregnancy. Her legs and arms were short and deformed and she measured only 3 feet 10 inches in height. Her pelvis was flat and asymmetrical. For this reason a low cesarean section was performed and what then appeared to be a normal female infant, weighing 6 pounds and 6 ounces, was delivered (see Case 2). A second child was delivered by section on Aug. 5, 1930, and the patient was sterilized. A tentative diagnosis of contracted pelvis probably

due to rickets was made at the time. This was not changed until four years later, when the first child was observed to be deformed in a fashion similar to the mother.

CASE 2: L. L., a colored female, age six, daughter of the patient described as Case 1, was admitted to the hospital on Nov. 18, 1934. As previously noted, she had been considered normal at birth. However, she had failed to grow at the normal rate and at six years of age she was 34 inches tall and weighed only 39 pounds. She did not walk until nineteen months of age. Mentally she had been very bright, beginning to talk at nine months. Her history revealed only the usual childhood diseases. One sister, living and well, was apparently normal.

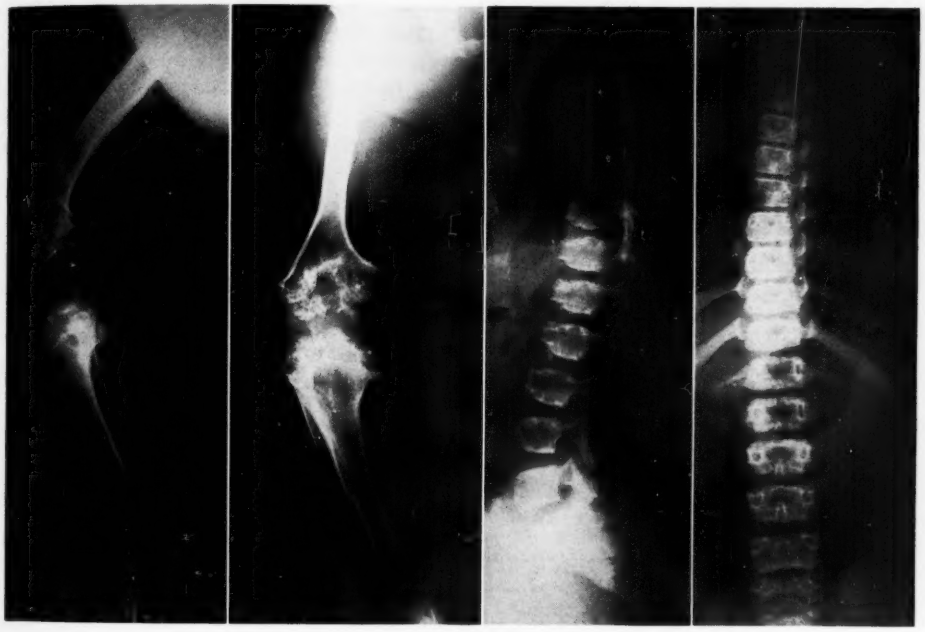
The child had a rather large head and short extremities. The torso appeared to be normal with the exception of a rather prominent sternum and some enlargement of the costochondral junctions. The abdomen was slightly enlarged and the liver was palpable. There was some lumbar lordosis. The extremities were short with considerable bowing of the legs. The epiphyses were quite prominent at the ends of all the long bones. The fingers were short and thick.

The blood findings were not unusual, and the urine was negative.

Roentgen examination of the forearms and lower extremities led to a diagnosis of achondroplasia. Osteotomies of the femora were done to straighten the lower extremities. Further roentgen examinations were made on March 11, 1940, for comparison and at this time the spine and skull were also x-rayed.

CASE 3: Baby A. C. F. C., mother of the patient, a 29-year-old colored woman, was admitted to the hospital on June 18, 1936, in active labor. Her history revealed six pregnancies including two miscarriages, one at one month and one at six weeks. The other four, including the present, were full-term. One child was stillborn and one died at two years of a streptococcus throat infection. The present child lived only six hours.

The mother was obese with a very large abdomen. The bag of waters was artificially ruptured and there was a marked polyhydramnios. There was considerable fetal distress and delivery was complicated



Figs. 3–6. Case 2: L. L., aged eleven. The roentgenogram to the extreme left shows increase in the size of the metaphyses and the irregular new bone growth in all directions. This conforms to Kaufmann's "hyperplastic type." The anterior-posterior view of lower extremity shows bowing most marked at the knee joint and in the tibia. An osteotomy was performed on the lower end of the femur to correct some of the bowing several years before this film was made.

Irregularity of vertebral bodies with wedging is seen on the roentgenogram of the spine. This seems to involve all of the dorsal and lumbar vertebrae. The cervical vertebrae were not examined. The anterior-posterior view of the spine shows slight lateral scoliosis.

by a transverse presentation. Version and extraction resulted in delivery of a premature male infant, which lived for six hours.

The autopsy report was as follows: premature chondrodystrophic dwarfed male infant; polydactylism of both hands; incomplete separation of the third toes of both feet; marked edema and hyperemia of the brain; patent foramen ovale; patent ductus arteriosus; patent umbilical veins and arteries; blue-gray irides; very small external genitalia.

The mother's blood calcium was 9.7; inorganic phosphorus 2.8.

CASE 4: Baby B. C. On Jan. 27, 1939, two and a half years after the birth of Baby A. C. (Case 3), F. C. gave birth to a full-term seven-pound female infant. The delivery was normal except that there was again a very pronounced polyhydramnios. There had been one miscarriage between the two births. Baby B. C. lived only six days. Roentgen examination established a diagnosis of achondroplasia foetalis. The autopsy findings were as follows: achondroplasia foetalis; congenital absence of the intra-auricular septum of the heart; bilateral atelectasis of the lungs; hypertrophy of the myocardium, especially of the left ventricle; hydroperitoneum; diminution of the lipoid material of the cortex of the right and left suprarenal; recent hemorrhage of the medulla of the right suprarenal; hyperplasia of the left suprarenal; hemorrhagic cysts of the liver; extensive recent hemorrhage into deep scalp tissues; supernumerary digits of both hands; congenital absence of the greater omentum; thymus gland present; accessory bronchus to right upper lobe of lung; persistent eustachian valve; persistent fetal lobulations of the kidneys.

It is of interest to note that during this last pregnancy the mother was given large doses of wheat-germ oil to aid in carrying the child to term.

CASE 5: C. L., a white female, age 2 years and 3 months, was brought to the hospital for roentgen examination of the skeleton on Feb. 27, 1940. Her history showed a normal delivery and there was no familial occurrence of dwarfism. During the past year the child had failed to grow at the normal rate, and the abdomen appeared to be enlarged. The family history was negative for syphilis. A physical examination revealed short extremities, a large pot belly, with a palpable liver. Subcutaneous fat was abundant and there were loose folds of soft tissue over the thighs. The head was within normal limits as to size. Roentgen examination substantiated a diagnosis of achondroplasia.

ETIOLOGY

The cause of achondroplasia has not been determined. There have been no significant theories advanced since Murk Jansen announced that the cause may lie in the amnion. Bargson's work in tracing the disease through five generations apparently establishes the fact that the condition is hereditary and is inherited in the mendelian order.

Jansen believed that the pathological changes were initiated between the third and eighth weeks of intra-uterine life, and in most cases were due to the smallness of the amnion, which caused an infolding of the fetus. He believed that hydramnios may be an influence, as it seems logical that increased pressure on the fetus may have a selective effect on the bones formed in cartilage, since they increase in volume more rapidly than other tissues. The cartilage cells are large and demand considerable nutrition in their growth. Thus increased intra-uterine pressure brought on by hydramnios might, in early pregnancy, have some influence on a select group of the fetal cellular structure.

Considering the well established hereditary nature of achondroplasia, we are inclined to go back further than the third week of intra-uterine life to establish a causative factor. Nevertheless, it should be noted that in our Cases 3 and 4, the mother had a rather pronounced polyhydramnios with both pregnancies and it seems safe to assume that there may have been some disturbance of the amnion.

PATHOLOGIC ANATOMY

Achondroplasia has been defined as primarily a defect in ossification confined to bones ossified in cartilage. The pathologic changes, then, can be foreseen if the bones of the skeleton which are preformed in cartilage are enumerated. The skeleton is mesodermal in origin, and the forerunner of the osseous system is a membranous or blastemal structure which is largely converted into cartilage from which the cartilaginous skeleton develops. Portions of this blastema retain their membranous structure and become converted directly into the membranous bone which comprises the cranial vault and face (Gray). Thus we may expect, and it has generally been shown to be true, that the cranial

vault will not be affected. Changes in the shape of the skull do occur, however, because its base is formed in cartilage. In more severe grades of the disorder there may be a foreshortening of the base. The usual picture is that of a brachycephalic head with a broad face, a sunken nasal bone, and possibly a small sella turcica. The actual volume of the cranial vault is never decreased and clinically these patients are almost always bright, or even above average in mental capacity.

The vertebral column is laid down in cartilage. The normal vertebra develops from three primary centers; one for the body, and one for each half of the neural arch. The centers for the neural arch grow forward to produce part of the posterior section of the body. Thus we might expect that a disturbance in this forward growth might cause a distortion in the spinal canal. Undoubtedly this happens occasionally. Freund reviewed the literature and found cases of spastic paraplegia in achondroplastic dwarfs.

ROENTGEN FINDINGS IN CHONDRO-OSTEO-DYSTROPHY

All dwarfs are not achondroplastics. Chondro-osteo-dystrophy, described by Morquio in 1928, may also produce a dwarfed skeleton, and definite irregularities in ossification can be demonstrated at the metaphyses. The condition is rare; the epiphyses are irregular and fragmented. The joint space is usually very wide. The epiphyses are soft and pressure deformities result. The disease seems to subside as the time for fusion of the epiphyses and diaphyses approaches. It has been attributed to some disturbance in the lipoid metabolism. These patients are often undeveloped, weak, complain of pain, enlarged joints, and deformities due to softening of the bones, in contradistinction to achondroplasia. It may also be noted that in achondroplasia there is no evidence of departure from the normal after birth.

Chondro-osteo-dystrophy is usually seen in children and young people under twenty years of age and of normal intelligence. The x-ray findings are most prominent in the epiphyses, which are deformed and fragmented. The epiphyses appear late and develop slowly. The bones are wide and short; the metaphyses wide and irregular. The softening of the bones is due to calcium deficiency. Brailsford stresses the widening of the joint spaces, often to twice the normal dimensions. Joint surfaces such as the glenoid and acetabulum are often irregular and flattened, due to the osteoporosis. The spine is frequently involved; the bodies of the vertebrae are flat and vary in size and shape. The skull is rather large, but normal. Occasionally the disease is confined to one bone.

ROENTGEN-RAY FINDINGS IN ACHONDROPLASIA

There are a number of bone diseases which may be confused with achondroplasia. There is often a combination of bone changes common to many diseases. In other words, the findings are not clear-cut. The literature presents patients in all probability properly called achondroplastic in whom the changes are most evident in the epiphyses, while others have normal epiphyses with extensive changes in the metaphyses. In most of the patients we have described in this paper and in previous papers, in 1923 and 1927, the paramount changes have been in the epiphyses. According to the description of Morquio, the cases described by us should be classified as chondro-osteo-dystrophy. The differential points seem to be that in Morquio's disease the changes become more pronounced as the patient walks, due to static strain on the soft bone. In achondroplasia there seems to be no progressive development of the bony changes. The metaphyses in our cases have presented a broad appearance with definite thickening, premature ossification, and limitation of growth. The epiphyses are slow to appear, irregular, and moth-eaten. The interarticular spaces have usually been increased due to the

small and poorly developed epiphyses. We believe the kyphosis at the base of the skull is due to premature ossification. Achondroplasia, as we reported in 1923, involves especially the epiphyses and the epiphyseal cartilages. Our subsequent cases have not altered our opinion. The interference with the epiphyses leads to greatly retarded growth. Often a complete arrest of development follows. Brailsford has stated that chondro-osteodystrophy may be confined to one bone. We have never seen this occur in achondroplasia (chondrodystrophia foetalis), as practically the entire osseous system is involved. The most extensive changes occur in the ends of the long bones. The periosteum seems to be exempt and there is no evidence of it being laid down in excess.

Inasmuch as achondroplasia is frequently found in the female, a brief review of the pelvic deformities is in order. In comparison with the normal, the changes are quite striking. The pelvic outlet is decreased, while the obturator foramina are enlarged. The bones of the pelvis seem soft and are partly decalcified. X-ray examination of the pelvis of the female patient is very important, especially if she is married and anticipates pregnancy.

The radiographic changes usually found in the spine are fragmentation and wedging of the bodies of the vertebrae. This has been shown many times and may occur in any or all sections of the vertebral column. Involvement of only a few of the bodies sometimes leads to a clinically pronounced kyphosis. The thoracic cage and abdomen may be normal, depending on the changes present in the spine. In some cases a marked dwarfing of the spinal column will lead to a "short" chest, and it will seem to be too small to contain all its organs. Similarly a "pot belly" may develop. This, however, may be secondary to a sluggish gastro-intestinal tract and weak abdominal musculature.

The extremities have been studied more frequently than other parts of the body, probably because the patients having only mild deformities, confined largely to the extremities, are those who live on and reach adult life. The average achondroplastic adult on casual observation may seem to be entirely normal except that his extremities are short and deformed. The changes take place in the growing ends of the long bones and are not due to a failure of growth, but to a disturbance in the order of growth and ossification. Instead of normal calcification of the cartilaginous matrix there is a general mucoid type of degeneration with a tendency of the growth to occur in all directions. This softening of the bones of the extremities may lead to all sorts of variations and deformities, depending on the stress to which they are subjected.

SUMMARY

(1) Five new cases of achondroplasia foetalis are reported.

(2) Four of the patients were Negroes. Few cases in colored patients have been previously reported.

(3) The pathologic anatomy and roentgen findings are discussed and illustrated.

(4) The differentiation between achondroplasia foetalis and chondro-osteo-dystrophy is often difficult. We believe that the two conditions are very closely related.

(5) The roentgen evidence in achondroplasia is most marked in the epiphyses and epiphyseal cartilages.

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DISCUSSION

George W. Grier, M.D. (Pittsburgh, Penna.): I have been puzzling for a number of years over the distinction between achondroplasia and chondrodystrophy. I have had the opposite view to that which Dr. Jenkinson has expressed. I have thought that the cases showing a short thick shaft and mushroom end were achondroplasia; and that those with destruction at the end of the metaphysis were chondrodystrophy.

The pathology is different in these two conditions. In achondroplasia there is an under-development of the cartilage at the epiphyseal line, but in chondrodystrophy the cartilage forms in globular shapes which project into the end of the shaft and produce a characteristic deformity. These deformities are sometimes described as areas of destruction, but actually they are areas of cartilage which fail to ossify. This condition is characteristic of chondrodystrophy, but is not seen in achondroplasia.

May I ask Dr. Jenkinson if this is his understanding of these two diseases?

Edward L. Jenkinson, M.D. (*closing*): I shall try to answer Dr. Grier's pertinent questions. The differentiation between achondroplasia foetalis and Morquio's disease, we believe, is very difficult. As I understand it, the changes described by Morquio present themselves later in life, usually after the child is up and about, attempting to walk. There seems to be a calcium deficiency in the bones and the static strain incidental to walking often leads to fragmentation of the epiphyses. This is what Morquio describes as osteochondrodystrophy, or Morquio's disease. Patients afflicted with the condition are usually not strong but are of normal intelligence. In contrast with achondroplastics, these patients are also weak sexually.

In our experience, the bone changes in achondroplasia have been present since intra-uterine life and in many cases the patients die at a very early age. Our opportunity to study several cases of the disease is due to the fact that the changes shown by these patients were not extensive and they were able to live on to adult life.

Attempts have been made to reproduce achondroplastic types by interbreeding. This was done a number of years ago but proved a complete failure.

In the literature on achondroplasia foetalis, there seems to be a lack of unanimity in regard to the differentiation between many of these so-called dystrophies. In our opinion, we see more cases of achondroplasia than we do of Morquio's disease.

Several years ago Dr. Lewin and I went over this subject; we visited circuses and every other place available in an attempt to differentiate between the types of dwarfism. It was our observation that the changes in achondroplasia are fundamentally in the epiphyses, which often showed fragmentation.

The diagnoses in the cases we have shown were made by the pathologist postmortem and were definitely achondroplasia foetalis. It would appear that sometimes these cases run in families, as one woman in our series had two children showing unmistakable achondroplasia foetalis.

In regard to treatment: one of our patients was put on wheat-germ oil prior to the delivery of her second child, but apparently to little effect.

One of our patients has been examined from birth to eleven years of age.

"Reversible" and "Irreversible" Massive Pulmonary Atelectasis: A Radiologic Study[1]

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THAT MASSIVE pulmonary atelectasis can strike with the dramatic abruptness and amazing swiftness of stark tragedy is admitted. Jones and Burford (1) reported (1938) four sudden deaths following administration of cyclopropane anesthesia, three of which took place immediately after operation, even before the patients could be wheeled back to their wards. A fourth patient succumbed on the operating table before the first incision could be made. While massive atelectasis of one or both lungs was found on necropsy to be the cause of death in these cases, the tracheobronchial pathways were patent; in no instance was gross bronchial obstruction found.

Such progressive or fatal massive pulmonary atelectasis, where re-aeration of the involved segments neither occurs nor is possible, may be termed clinically "irreversible" atelectasis. The mechanism of its occurrence in the cases cited not only is vaguely understood but appears to differ from that of "irreversible" atelectasis encountered in pulmonary tuberculosis.

It has been repeatedly pointed out in effect (2–4) that pulmonary atelectasis occurs so frequently in lung phthisis that its bearing upon the evolution and cure of the disease deserves emphasis. Concurring with this assertion, we desire to present some observations gleaned from a radiologic study of cases at the Quezon Institute for Tuberculosis.

Though the radiologic pattern of massive pulmonary atelectasis had impressed us time and again, its verification in the living subject proved a difficult task, since the condition is not always permanent or "irreversible." The "reversible" type of atelectasis, in which pulmonary re-aeration supervenes upon elimination of the cause of bronchial obstruction, obviously cannot be confirmed at the necropsy table.

A radiologic method seemed, therefore, the only means of establishing our previous impression and confirming the diagnosis of the condition in the living subject.

The following classification of massive pulmonary atelectasis is proposed.

A. "Reversible" type (re-aeration possible)
   Bronchial obstruction due to
   1. Thick inspissated secretions
   2. Blood clots, as in hemoptysis
   3. Foreign bodies retrievable by bronchoscopy
   4. Operable bronchogenic tumors
   5. Edema of bronchial mucosa
      (*a*) Inflammatory
      (*b*) Allergic
   6. Intrapleural compression
      (*a*) Therapeutic, as in artificial pneumothorax, oleothorax
      (*b*) Benign spontaneous pneumothorax
      (*c*) Hydrothorax
      (*d*) Pyothorax

B. "Irreversible" type (permanent, progressive, or fatal)
   I. Bronchial obstruction due to
   1. Flooding of tracheobronchial tree in arterial pulmonary hemorrhage
   2. Inoperable bronchogenic neoplasms
   3. Pressure on bronchi by neighboring tumors
      (*a*) Pulmonary
      (*b*) Mediastinal
      (*c*) Pleural
   4. Irretrieved foreign bodies
   5. Tracheobronchial tuberculosis
      (*a*) Bronchial tuberculous granulomatous masses
      (*b*) Pressure on bronchi by large calcified or caseous lymph nodes
   6. Bronchial kinking set up by shrinking fibrous bundles
   7. Intrapleural compression
      (*a*) Malignant spontaneous pneumothorax
      (*b*) Fatal hydrothorax or pyothorax
   8. Therapeutic extrapleural compression
      (*a*) Thoracoplasty
      (*b*) Apicolysis with packing

[1] From the X-Ray Department, Quezon Institute for Tuberculosis, Manila, P. I. Presented before the Sixth Scientific Meeting of the Manila Medical Society, held at the Quezon Institute, Sept. 10, 1940. Accepted for publication in December 1940.

9. Congenital, in the stillborn fetus

II. Without gross tracheobronchial obstruction, occurring during or after administration of general anesthesia (1).

PHYSIOLOGICAL CONSIDERATIONS

The lungs, being air-containing organs, are frequently subject either to hypo-aeration or hyper-aeration. Not only do posture and varying shades of physical activity play a rôle in this respect, but fluctuations in the carbon dioxide content of the blood and pain associated with the respiratory act may contribute to hypo-aeration or hyper-aeration of some of the pulmonary segments. It is difficult to conceive, therefore, that *all* the pulmonary alveoli will be fully distended to capacity by inrushing air with *every* inspiratory effort taken throughout a lifetime.

In prolonged recumbency, for instance, such as is enforced by extrapulmonary ailments of long standing, even though the seat of disease is elsewhere, some pulmonary segments are bound to be more or less aerated than others, giving rise to atelectasis in some areas (5). The so-called "terminal" bronchopneumonias and hypostatic pneumonias in persons long confined to bed have been ascribed largely to atelectasis by Sewall (6) and Krehl (7).

Postoperative atelectasis, which has occurred (1930) in as many as 67 per cent of an observed series of 456 operations (8), is probably set up by restriction of the cough reflex and the respiratory act, alike by postoperative pain, giving rise to bronchial plugging with thick retained secretions.

In "reversible" atelectasis, where bronchial occlusion is caused by blood clots during hemoptysis, by foreign bodies suddenly finding lodgment in the bronchi, or by bulky caseous secretions, cardiorespiratory distress is the general rule. Here bronchial obstruction has set in so abruptly as to allow the cardiorespiratory mechanism no opportunity for compensatory readjustment. Dyspnea, an accelerated heart rate, and cyanosis result from the sudden strain thrown upon the cardiorespiratory processes. The mechanism of production of the striking dyspnea is identical with that in malignant spontaneous pneumothorax of the valvular type: (1) depletion of the respiratory reserve; (2) great strain abruptly shifted to the right chambers of the heart; (3) resulting anoxemia and histotoxic anoxia. Other contributory factors are the increased negativity of the intrapleural pressure of the involved hemithorax, consequent to shrinkage in volume of the atelectatic lung, and shifting of the mediastinal contents toward the involved side.

On the other hand, very little or no manifestation of cardiorespiratory distress is found in most cases of "irreversible" atelectasis, which are not immediately fatal. The relative absence of dyspnea in these cases may be explained by the interval afforded the cardiorespiratory mechanism for compensation during the gradual development of the atelectasis.

OCCURRENCE IN TUBERCULOSIS

Bernardo (9) of the Quezon Institute informs us that he has come upon 12 instances of secondary atelectasis among 219 consecutive autopsies, a percentage of 5.5.

As it is recognized that blood clots or tenacious secretions in the bronchi give rise to temporary or "reversible" atelectasis, so is it likewise true that tracheobronchial tuberculosis is largely responsible for permanent, progressive, or "irreversible" atelectasis in pulmonary tuberculosis (10, 11, 12). To Hennell (13), atelectasis is the essential mechanism involved in "unilateral advanced fibroid pulmonary tuberculosis," with extensive pulmonary fibrosis following close upon its heels. This has been verified by Sanes and Smith (14).

Areas of density in the region of the right upper lobe including circular radiolucent areas have repeatedly attracted our attention in the course of thousands of fluoroscopic examinations. The marked contraction of the homolateral apex in these cases inevitably suggests atelectatic consolidation of the involved lobe. One such case is illustrated in Figures 1-A and 1-B. Tomographic exposure in this case revealed a multilocular cavity located

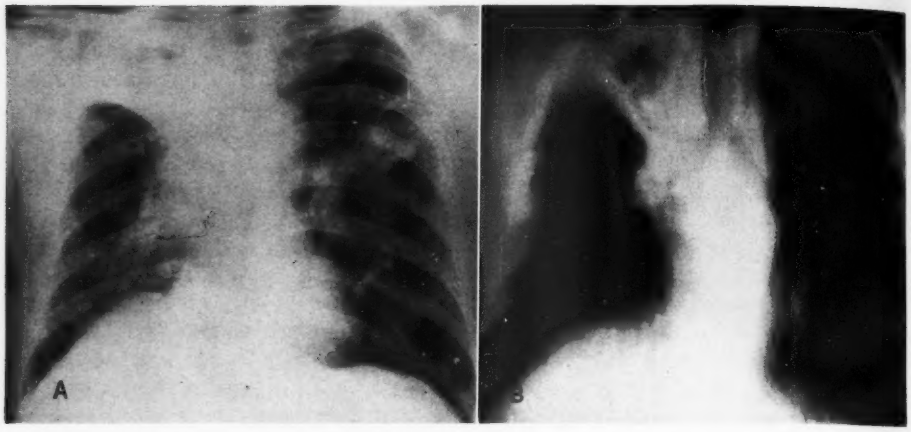

Fig. 1. A. G., 48 years, tuberculous diabetic. A. Conventional teleroentgenogram, Oct. 18, 1939. Infraclavicular radiolucent area within area of density, corresponding to contracted right upper lobe. Suggestion of cavity in contralateral mid-lung zone. Elevated right diaphragm.

B. Tomographic exposure of plane 9.5 cm. from back of patient, Oct. 18, 1939, confirming presence of septate cavity, with two draining bronchi, within shrunken atelectatic right upper lobe. Draining bronchi clearly outlined joining eparterial trunk of right main bronchus. Large caseous node in right hilum. Presence of contralateral cavity likewise confirmed.

within a fibrotic, shrunken, atelectatic right upper lobe.

Moreover, the malignant variety of "irreversible" atelectasis consequent to the flooding of the tracheobronchial pathway in arterial pulmonary hemorrhage is a familiar event to the student of tuberculosis. The fatal and dramatic termination of such cases can be due only to this type of massive atelectasis of both lungs, which can be confirmed by necropsy.

METHOD OF STUDY

Serial teleroentgenograms, as well as anteroposterior or lateral tomographic exposures of the chest, were made in the four cases comprising this study to ascertain the presence of atelectatic pulmonary consolidation in the living subject. Tomographic exposures were especially useful in differentiating between pleural and pulmonary opacities, which gave identical features at times on the conventional chest roentgenogram.

Tomographic exposures of the chest—whether anteroposterior or lateral—particularly in the presence of contrast pneumothorax, yielded such precise information on the x-ray representation of the particular plane or section in focus that the parenchymal condition of the lung segments concerned was ascertained with ease. The thickness of the plane of the chest within focus during each tomographic exposure has been found (1939) to be approximately 5 mm. (15).

Of four cases herewith reported, three were frank lung tuberculosis and the fourth was non-tuberculous. In the last case, the bronchial obstruction was verified not only by a lipiodol bronchogram but by bronchoscopic examination as well.

CASE 1: "Irreversible" Atelectasis. R. M., an 18-year-old male Filipino student, applied, walking, at the dispensary service of the Quezon Institute, on Sept. 18, 1939, complaining of cough and streaks of blood in the sputum. His mother had died of tuberculosis. The present illness was of a year's duration, starting with cough, of an intermittent character, accompanied at times by slight afternoon fever and back pains. A week before examination the patient had noticed streaks of blood in his sputum.

Physical examination showed decreased breathing over the left suprascapular and upper interscapular areas with impairment of resonance and occasional mucous râles. Tactile fremitus and vocal resonance were also diminished over the same areas.

On fluoroscopic examination, a diffuse density involving the upper half of the left lung field was seen; the left half of the diaphragm was sluggish and

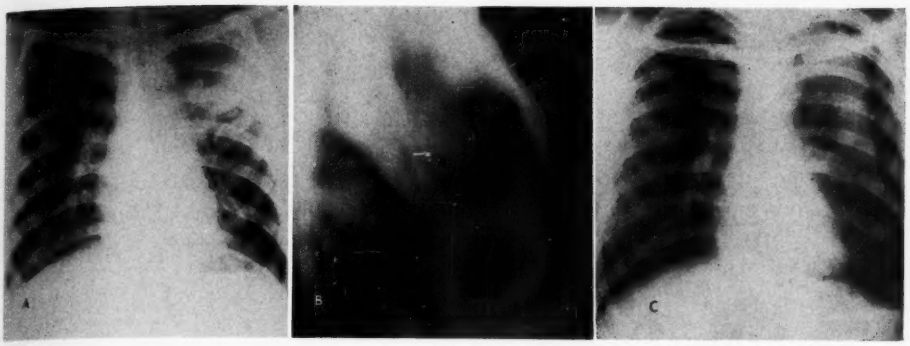

Fig. 2. Case 1: "Irreversible" atelectasis. A. Conventional teleroentgenogram, Sept. 27, 1939, showing diffuse patchy density in left upper lobe. Note contraction of left apex; trachea and aorta drawn to left; left half of diaphragm raised to level of right. Compensatory emphysema elsewhere.

B. Lateral tomogram of plane 7.5 cm. to left of spine, Sept. 28, 1939, just after induced pneumothorax, confirming atelectatic consolidation of apical and paravertebral segments, left upper lobe.

C. Conventional teleroentgenogram, Oct. 10, 1939. Apex and axillary area of left upper lobe still dense in presence of selective lateral collapse. Note adherent apex; effusion at left costophrenic angle; descent of left half of diaphragm.

slightly raised; there was also an appreciable drawing of the heart and mediastinum to the left side.

Two sputum examinations, Sept. 19 and 21, were negative for acid-fast bacilli, but on Sept. 25 the examination was reported positive.

Teleradiography of the chest, Sept. 27 (Fig. 2-A) confirmed the previous fluoroscopic findings. The skiagram showed a diffuse patchy density of the upper two-thirds of the left lung field with narrowing of the uppermost left intercostal spaces. The left half of the diaphragm was raised to the same level as the right and there was a drawing of the heart, mediastinum, and trachea over to the left side. Left artificial pneumothorax was induced.

The day following the induction of pneumothorax, two left lateral tomcgraphic exposures, 5 cm. and 7.5 cm. to the left of the spine, showed a consolidation of the segments of the upper lobe of the left lung drained by the apical and paravertebral divisions of the left upper lobe bronchus (Fig. 2-B).

Another roentgenogram, taken thirteen days after the beginning of treatment, showed about 20 per cent pneumothorax compre_sion of the dense upper lobe with the apex apparently adherent to the chest wall (Fig. 2-C).

Comment: Dyspnea was absent in this case of "irreversible" atelectasis of segments of the left upper lobe. As in Cases 2 and 4, frank tuberculosis was present. Tomographic exposures in the lateral position offered valuable information on the parenchymal condition of the affected segments of the left lung. Such exposures, particularly in the presence of diagnostic pneumothorax, may yield additional data which are not available in the conventional x-ray film.

CASE 2: "Irreversible" Massive Atelectasis. S. G., a 39-year-old male Filipino, a provincial governor, was admitted, walking, on Feb. 8, 1938, suffering from occasional attacks of dyspnea, productive cough, and fever. The family history for tuberculosis was positive, a brother and an uncle having died of the disease.

The patient stated that the present illness had begun more than a year before admission, with cough, productive of mucopurulent expectoration, later followed by intermittent afternoon fever. Two months before admission he began to have periodic attacks of dyspnea, which he attributed to asthma. Blood-streaked sputum was occasionally present.

Physical examination showed the right half of the thorax lagging behind the left in respiratory excursions. The percussion note was dull on this side, especially at the base; the breath sounds were weak, and vocal and tactile fremitus was diminished. Harsh breath sounds with abundant sibilant and subcrepitant râles were heard over the right apex. The left lung gave a few crepitant râles, with slight bronchial breathing over the supraclavicular and infraclavicular areas.

The sputum was repeatedly positive for acid-fast bacilli.

The first roentgenogram of the chest was taken on Feb. 24, 1932, six years before admission (Fig. 3-A). It revealed bronchopneumonic lesions in the lower half of the right lung field with an irregularly shaped annular shadow over the anterior end of the fourth rib, $1^1/_2$ inches in diameter.

Another conventional film of the chest, made just

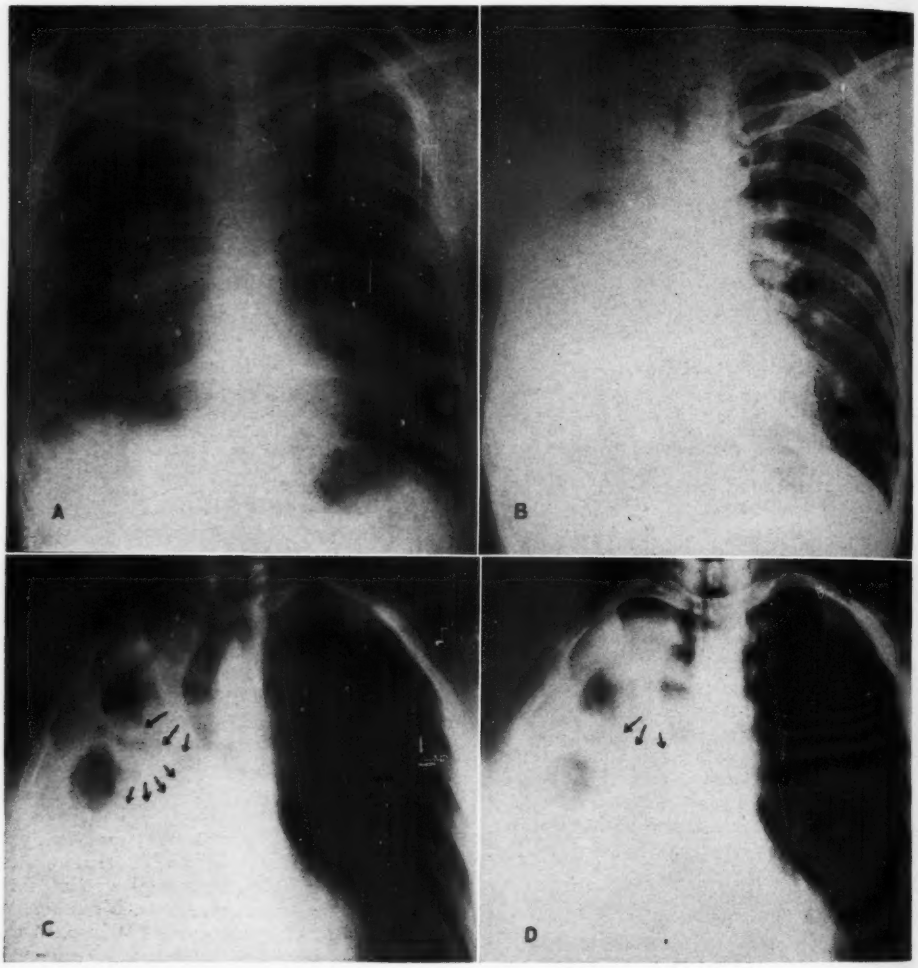

Fig. 3. Case 2: "Irreversible" massive atelectasis. A. Conventional chest film, Feb. 24, 1932. Pear-shaped annular shadow, 1 1/2 in. in diameter, at anterior end of right fourth rib; bronchopneumonic foci in lower half of right lung field.

B. Conventional teleroentgenogram, a few months after admission (February 1938). Note homogeneously dense contracted right hemithorax; trachea and mediastinum now drawn over to right; compensatory emphysema, left. Radiolucent area has ascended to right second intercostal space; another radiolucent focus infraclavicularly.

C. Tomogram, Sept. 30, 1938, of plane 2 cm. behind clavicle, revealing atelectatic consolidation of right lung with two cavities, each 1 1/4 in. in diameter, at first and second intercostal spaces, respectively. Draining bronchus of superior cavity (indicated by arrows) joins eparterial bronchus; that of inferior cavity (see arrows) joins hyparterial trunk. Trachea sharply drawn over to right. Liver density merges with pulmonary opacity.

D. Tomogram of plane 4 cm. behind clavicle, confirming findings revealed in C.

before admission, revealed a homogeneous density in the right lower hemithorax. The cavity seen in the previous film was still visible as a circular area of translucency which had ascended to the third anterior rib. The right hemithorax was now contracted, and there was some heterogeneous density in its upper third. The trachea and heart were retracted toward the right side.

A few months after admission (Fig. 3-B), the contraction of the right hemithorax was more appreciable; the density of the whole right hemithorax was more pronounced, with two areas of radiolucency at the first and second right intercostal spaces, respectively. The trachea, heart, and mediastinum were drawn over to the right side. The right half of the diaphragm was not visible, the liver shadow merging

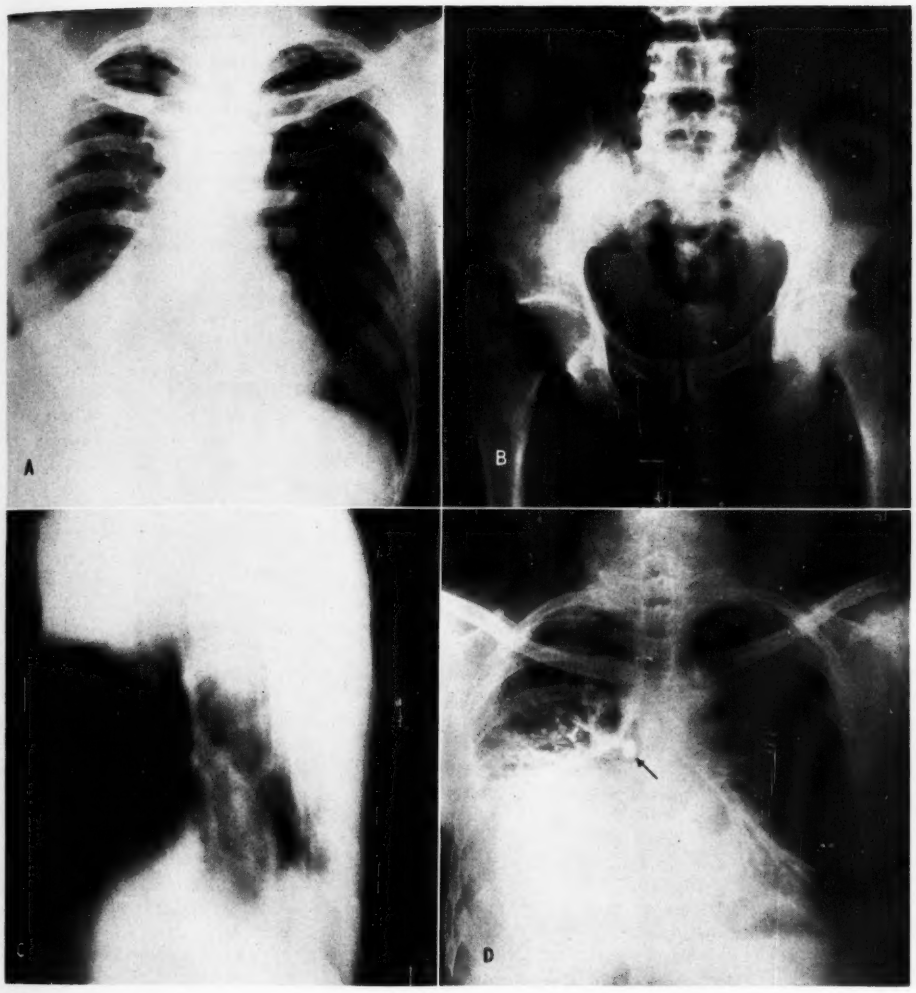

Fig. 4. Case 3: "Irreversible" massive atelectasis. A. Conventional teleroentgenogram, Sept. 2, 1940, revealing a homogeneously dense, well circumscribed shadow at the base of the right hemithorax, fusing with liver and right auricular density; right apex contracted. Lateral tomographic exposure (C) of plane 5 cm. to right of spine, showed this density to be due to a contracted, atelectatic middle lobe and involvement of the anterolateral and posterolateral segments of right lower lobe.

B. Anteroposterior roentgenogram of pelvis and hip joints, Sept. 2, 1940, revealing a fusiform radiolucent area (5 mm. × 3 cm.) at region of left anterior inferior iliac spine (see arrow); marked osteoporosis, upper femur, right; beginning destructive changes at superolateral portion of the greater trochanter.

D. Teleroentgenogram with lipiodol, Sept. 11, 1940. Atelectasis has progressed to include both right lower and middle lobes. Note how the contrast bronchogram outlines complete obstruction of hyparterial trunk (indicated by arrow) of right main bronchus, shown by bronchoscopy as due probably to bronchogenic new growth.

indistinguishably with the opacity in the right side of the chest, which was markedly contracted. The left lung field showed evidence of compensatory emphysema.

Tomographic exposures of the chest in the anteroposterior position on Sept. 30, 1938 (Figs. 3-C and 3-D), revealed consolidation of the whole right lung with two radiolucent areas (about 1-1/4 inches in diameter) at the first and second intercostal spaces. The bronchi draining the two cavities were clearly demonstrated: that draining the superior cavity came from the eparterial trunk of the right main bronchus and that draining the inferior cavity joined the hyparterial trunk. The trachea was drawn over

to the right side and the pulmonary density could not be differentiated from the liver density.

Serial films of the chest and repeated physical examination revealed no change in the massive consolidation of the right lung from the time of admission up to the patient's discharge on March 19, 1939. He is still living.

Comment: This case is typical of the "irreversible" type of massive atelectasis in tuberculosis. The atelectatic consolidation and shrinkage of the right lung on admission, which were absent in the first film six years earlier, remained throughout the patient's thirteen months' stay at the Institute. Attacks of dyspnea were present, but were not severe in character. This case illustrates the possibility of cavities being present within an area of pulmonary consolidation. Bronchoscopic examination of the case would have yielded valuable data on the cause of bronchial obstruction.

CASE 3: "Irreversible" Massive Atelectasis. A. C., a 40-year-old male Filipino farmer, was admitted to the bone and joint service of the Quezon Institute on Sept. 2, 1940, because of inability to walk and pain in the right hip.

Three months before admission the sputum was blood-streaked for one week, and there had been occasional cough for the past seven months. Two weeks after noticing the blood-streaked sputum, the patient was examined fluoroscopically and some density was discovered in the base of the right lung, for which rest was advised.

The present illness began two months before admission with occasional pain in the right hip region. Two weeks later the pain became constant, although the patient was still able to walk with a limp. Some days later, pain became severe, disturbing his sleep and confining him to bed. He was in the Philippine General Hospital for one week before his admission to this Institute.

Physical examination showed a lagging of the right chest at the base, especially in the infra-axillary area; impaired resonance, three fingerbreadths below the inferior angle of the scapula and downward, extending into the infra-axillary area, where there was distinct dullness. Over this area of impaired resonance were weak harsh breath sounds growing much more faint over the dull area beneath the axillary region. Vocal and tactile fremitus were diminished over the same areas. Exaggerated respiratory murmurs were heard over other areas.

The apex beat was not palpable, but the cardiac area of dullness appeared to be drawn toward the sternum on the left side.

On palpation there was a fullness over the right hip joint extending from the region of the great trochanter anteriorly, but without redness of the overlying skin or any increase in local heat. There was distinct limitation of movement of the right thigh, especially on internal rotation and adduction. This member was smaller by 3 cm. than the left. There was tenderness in the region of the great trochanter of the right femur and the anterior inferior iliac spine of the left. The right lower extremity was held in a slightly flexed, abducted, and externally rotated position.

A roentgenogram of the chest on admission (Fig. 4-A) revealed in the base of the right hemithorax a dense triangular shadow, merging with that of the heart and ascending aorta, the upper and outer border of which extended downward and outward to well above the costophrenic sinus, obliterating this and the cardiophrenic angles; there were prominent bronchovascular markings suggestive of emphysema in the rest of the lung zone, and marked apical contraction on the right side.

Roentgen examination of the pelvis on the same date (Fig. 4-B) showed marked osteoporosis involving the upper third of the right femur, with signs of beginning destructive changes at the superolateral portion of the great trochanter and a localized fusiform area of lessened density (5 × 3 cm.) in the region of the left anterior inferior iliac spine.

Two days later, right lateral tomographic exposure of the chest, 5 cm. to the right of the spinous processes (Fig. 4-C), showed the lung density to involve the middle lobe and those segments of the lower lobe drained by the posterolateral and anterolateral divisions of the lower lobe bronchus. The sputum was repeatedly negative for acid-fast organisms.

Ten days after admission intratracheal instillation of lipiodol (Fig. 4-D) revealed complete obstruction of the right hyparterial bronchus and a diffuse density in the lower half of the right lung field, corresponding to the areas of the middle and lower lobes.

Bronchoscopic examination fifteen days after bronchography showed the carina to be thickened and foreshortened and a bulging mass completely plugging the right hyparterial bronchus, which bled easily upon the slightest touch. The bronchoscopist's (Dr. V. C. Alcantara, Philippine General Hospital) impression was a bronchogenic new growth.

Two weeks later a lump appeared in the region of the right hip joint, but the patient went home against advice on October 5, 1940, before a biopsy could be done.

Comment: It is to be regretted that biopsy of neither the bronchogenic nor the bone growth was made. The case was one of "irreversible" massive pulmonary atelectasis apparently due to a bronchogenic neoplasm. There was no complaint of dyspnea, the joint involvement apparently

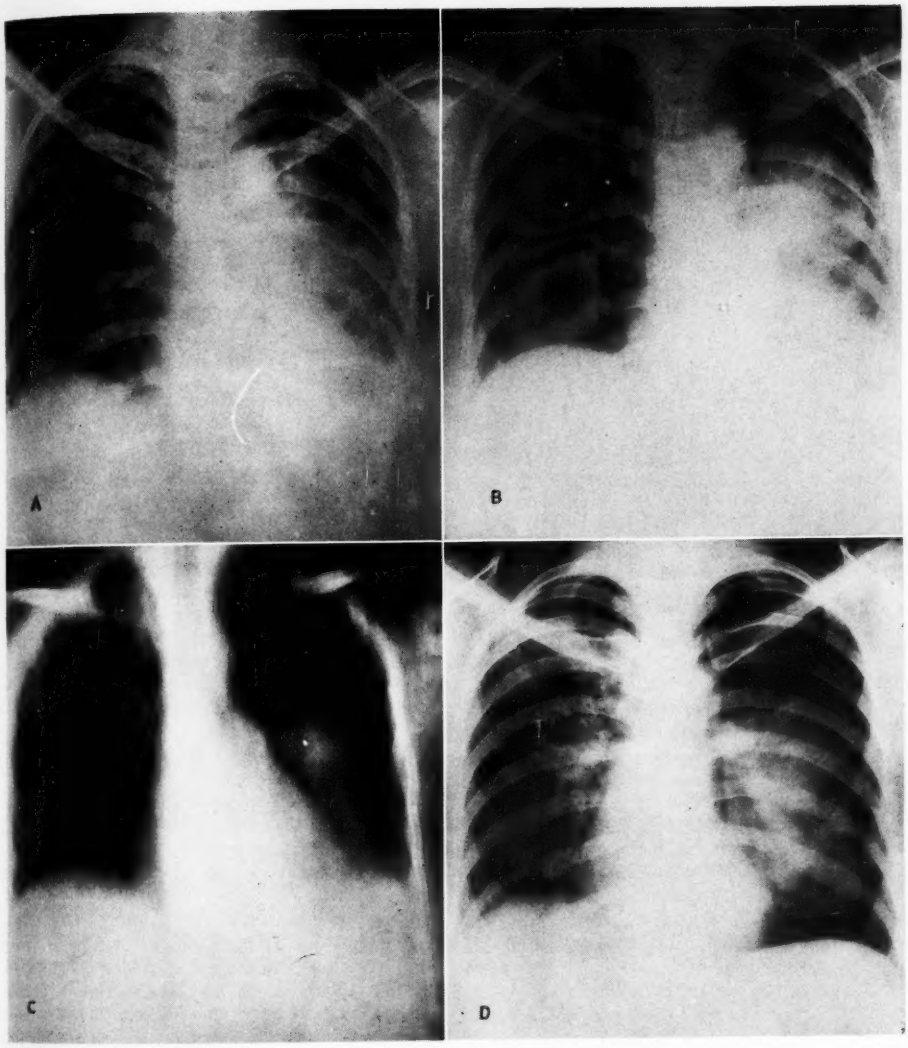

Fig. 5. Case 4: "Reversible" massive atelectasis. A. Conventional teleroentgenogram before admission, Aug. 25, 1939. Ground-glass opacity of left hemithorax, more pronounced at hilum; narrowed left intercostal spaces; trachea and heart sharply drawn over to left; left half of diaphragm elevated; and compensatory emphysema, right lung field. This patient showed severe dyspnea occurring after profuse hemoptysis.

B. Teleroentgenogram, Aug. 26, 1939, after insufflation of 300 c.c. air the day before. Left pulmonary apex has fallen to level of first rib; left lung dense; left half of diaphragm outlined to same level as right. Note how contraction of involved hemithorax and mediastinal shifting have decreased. Intrapleural pressure just after x-ray −13 cm. to −10 cm. of water.

C. Tomographic exposure of plane 11 cm. from back of patient, Aug. 28, 1939, showing trachea, heart, and mediastinum returned to normal position; left pneumothorax with 60 per cent pulmonary collapse; atelectatic left lung.

D. Teleroentgenogram, Sept. 6, 1939. Note beginning re-aeration at apex, base, and periphery of left lung; descent of left half of diaphragm; presence of small pneumothorax, left; "shower spread" of diffuse bronchopneumonic lesions to contralateral lung.

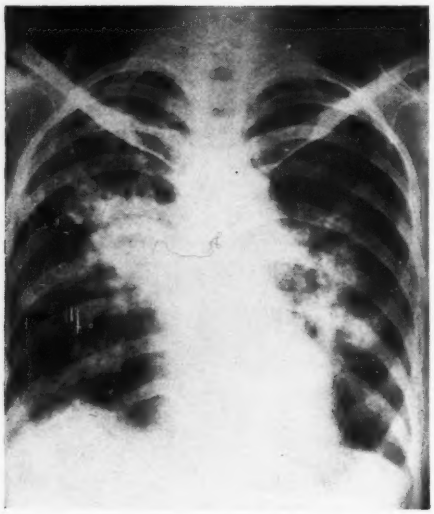

Fig. 6. Case 4: Teleroentgenogram a year later than that shown in Fig. 5-D. Left lung now re-aerated but disease progression is present. Compare with Fig. 5-A.

having bothered the patient more than that of the lungs.

CASE 4: "Reversible" Massive Atelectasis. V. G., a 29-year-old female Filipino housewife, was admitted on Aug. 25, 1939, as an emergency patient, complaining of severe dyspnea, fever, and blood-streaked sputum. Her mother had pulmonary tuberculosis. Her own illness started with profuse hemoptysis during sleep the night before admission. Awakened by a sensation of choking, she spat out about enough blood to fill a sputum cup. The following morning—that is, on the day of admission—high fever and slight difficulty of breathing appeared. Within a few hours bleeding again occurred and the dyspnea grew worse.

On admission, the patient was febrile, dyspneic, listless, and cyanotic. Physical examination revealed an obvious lagging of the left hemithorax, with a dull percussion note over the left interscapular, infrascapular, and infra-axillary areas, almost flat at the base. Vocal and tactile fremitus were diminished in the same areas. Breath sounds were inaudible except in the left supraclavicular and a limited portion of the infraclavicular area, where they were weak and distant but harsh. The apex beat was visible lateral to the left anterior axillary line. The right hemithorax was tympanitic with exaggerated respiratory murmurs. Heart sounds were strong, very rapid but rhythmic, without murmurs.

A conventional roentgenogram of the chest before admission (Fig. 5-A) revealed a "ground-glass" opacity in the left hemithorax, denser in and around the hilum; depression of the left apex; narrowing of the left intercostal spaces; drawing over of the heart and mediastinum toward the left side; elevation of the left half of the diaphragm. The right lung field showed evidence of compensatory emphysema. Fluoroscopic examination revealed immobility of the elevated left half of the diaphragm.

Left artificial pneumothorax, instituted forthwith, revealed an initial manometric reading of −10 to −7 cm. of water. Three hundred c.c. of air were insufflated. The intrapleural pressure became more negative the next day, reaching −13 to −10 cm. of water. A roentgenogram on the same date (Fig. 5-B) revealed pneumothorax around the upper lobe; the apex had dropped down to the level of the first anterior rib; the left lung appeared dense, and the left hemidiaphragm was outlined at the same level as the right.

A tomographic exposure in the anteroposterior position taken two days later at a plane 11.0 cm. from the back of the patient (Fig. 5-C), revealed a dense left lung, compressed by 60 per cent pneumothorax. The heart and mediastinum had returned to their normal position.

Another conventional film, twelve days after admission (Fig. 5-D), revealed 30 per cent pneumothorax compression of the left lung with beginning re-aeration of the base, apex, and periphery. Unfortunately, a "shower spread" of bronchopneumonic lesions was present in the right upper lobe.

Sputum was found negative for acid-fast bacilli on Aug. 26 and Sept. 16, 1939, but was positive, three plus (+++), on Sept. 21.

There was relief from dyspnea after each hypotensive pneumothorax refill.

The vital capacity on Sept. 28, 1939, was only 900 c.c.; on Oct. 19, it was 1,000 c.c. The pneumothorax was abandoned due to too low vital capacity coupled with the progression of lesions in the contralateral lung.

The patient was discharged unimproved on Dec. 7, 1939. A year after onset she was re-examined and another conventional roentgenogram of the chest was taken (Fig. 6). The left lung was now re-aerated and the contraction of the left hemithorax had disappeared; but the tuberculous pulmonary lesions had progressed. The left lung was functioning but all the clinical signs pointed to bilateral advanced tuberculous pulmonary disease.

Comment: This appears to be the first report of massive atelectasis of an entire lung in a Filipino. It is representative of the "reversible" form of massive atelectasis in lung tuberculosis. Follow-up, a year after onset, revealed re-aeration of the atelectatic left lung after the cause of bronchial obstruction had been spontaneously expelled. It appears likely that blood clots after hemoptysis incited the

massive atelectasis after plugging of the main bronchus in the left side.

The actual vital capacity of this patient has been lowered to 900 c.c. Abrupt suppression of the respiratory reserve, such as we have here, is one of the causes of the striking respiratory distress in this condition.

The respiratory distress in this patient was partly relieved by repeated insufflations of air into the left pleural cavity, which showed as high a negative reading as −13 cm. of water. The intrapleural insufflations of air, in lowering the abnormally high negative pressure, most probably lessened the torsion of the heart and mediastinum and in this fashion accounted for some of the relief of dyspnea observed with each pneumothorax insufflation.

SUMMARY

(1) Massive pulmonary atelectasis is classified into "reversible" and "irreversible" types, depending upon the possibility or impossibility of the occurrence of pulmonary re-aeration.

(2) A radiologic method is given of ascertaining the presence of atelectatic consolidation of the lungs in the living subject with anteroposterior or lateral tomographic exposures, with or without contrast pneumothorax.

(3) In three reported cases of "irreversible" atelectasis (one non-tuberculous), dyspnea was not a prominent symptom; in one reported case of "reversible" atelectasis, dyspnea was the striking clinical feature, after hemoptysis, partly relieved by pneumothorax insufflations.

(4) Patent cavities may be located within an area of atelectatic pulmonary consolidation.

(5) Massive pulmonary atelectasis in Filipinos is not as rare as is currently believed; the "reversible" variety, on account of its temporary character, is more difficult to diagnose than the permanent, progressive, or fatal "irreversible" type.

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Recurrent Postoperative Atelectasis[1]

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MASSIVE COLLAPSE is a definite clinical entity (1, 2) due to complete bronchial obstruction, subsequent absorption of the retained air, and atelectasis of the area corresponding to the occluded bronchus.

Historical surveys are most interesting (1, 2, 3). Schenk (4), in 1811, first described the condition in infants. Louis (5), in 1829, first described the lesion in adults. Jörg (6), in 1834, gave it the name atelectasis, *i.e.*, imperfect expansion. Mendelssohn (7) and Traube (8) first produced the lesion experimentally. The condition was carefully studied by Gairdner (9, 10, 11), who first described the mucous plug (12) as the major causative factor in atelectasis. The theory of its ball-valve action (9), later championed by Jackson and Lee (13), has since been abandoned. That the retained air is absorbed by the blood was originally suggested by Fuchs (14), in 1849, and again by Bartels (15) in 1861; the rate of absorption was first determined by Lichtheim (16), in 1878. The earliest record of postoperative atelectasis is probably that of Barr (17) in 1907. Pasteur (18–24) first established the modern conception of the condition in 1910 and authoritatively in 1914.

Elliott and Dingley (25) first stressed the importance of the obstructing bronchial secretion in postoperative collapse of the lungs; this was later emphasized by Jackson *et al.* (26), and confirmed simultaneously and independently by the refined experiments of Coryllos and Birnbaum (27) and Lee *et al.* (28, 29). The characteristic sputum (2) is a thick, pearly, yellow, gelatinous, tenacious, firmly adhering material. The use of the bronchoscope for the diagnosis and treatment of the condition was first suggested by Leopold (30), and first reported by Jackson and Lee (13). Bronchoscopic results (31–33) and reported relapses (33–35) add weight to the hypothesis of bronchial obstruction. With this and other evidence (36–40) favoring the theory, it seems hard to deny the primary importance of bronchial obstruction in the production of postoperative atelectasis.

There is, nevertheless, a large amount of evidence against the bronchial obstruction theory. Pasteur never accepted it (21–23, 41), citing (24) a well marked case without cough or expectoration. Bradford (42) describes contralateral collapse in a soldier who walked four miles following a nonpenetrating wound of the chest. Bergamini and Shepard (43) report two sudden deaths during operation, from bilateral massive collapse without obstruction or secretion in the bronchi. Santee (44) describes an additional case without necropsy evidence of obstruction. Ball (45) reports four cases following thyroid surgery with recurrent laryngeal nerve injury and subsequent tracheotomy without significant necropsy findings, and another fatal (bilateral) case (46), following acute pancreatitis without bronchial obstruction. Lilienthal (47), while removing a fibroma from the upper thorax, observed sudden collapse of the right upper lobe; death occurring within forty-eight hours. Necropsy revealed the lobe still collapsed without bronchial obstruction. Sante's cases (48, 49) may be pertinent. A patient described by Overholt *et al.* (50) without cough or sputum developed complete collapse and cleared, essentially, without treatment. In head injuries (2, 42) and intracranial operations (51), the complication is seen rarely, if at all. Following tonsillectomy (52) it is of rare occurrence. Experimentally,

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uncomplicated bronchial obstruction without resulting atelectasis has been recorded (53), forced respiration being previously reported as an essential factor. The mere fact that experimental atelectasis has been produced by no other method (54) should not argue too strongly (2) against other theories. Although bronchial obstruction seems to be most important, it cannot be said to be the sole etiologic factor (2) in postoperative pulmonary collapse.

Carlson and Luckhardt (55) report a most important reflex, *via* the vagus, which directly affects the lung and so may cause atelectasis. Reflex action is mentioned by Bradford (42) and approved by Sante (48). Dixon and Brodie (56) support a vagal reflex theory, as do others (57–59). Scott and Joelson (59) believe that such an initial pulmonary reflex (with a vasomotor factor) is the fundamental mechanism and that bronchial obstruction, assisted by posture and tenacious sputum, lateralizes the lesion. Compensatory emphysema keeps the opposite air passages open; failure resulting in bilateral atelectasis. In favor of such a bilateral reflex, these writers (59, 60) mention the common occurrence of the less extensive postoperative bilateral atelectasis (60, 61). Perhaps, although more difficult to recognize, this is the more common form; the more striking unilateral form not occurring unless bronchial obstruction becomes complete. Occurrence after local anesthesia, with distant trauma, as circumcision (62), and with non-penetrating wounds (42, 63), the increased incidence among patients with neurotic stigmata (40, 58) and autonomic imbalance (59), as well as the increased susceptibility of certain patients, as evidenced by recurrence (59), all favor such a theory. The rapidly changing lung findings, the sibilant, sonorous râles, which change to whistling asthmatic squeaks and quickly disappear without moist râles or expectoration, suggest (58, 59) that the bronchial lumina are undergoing rapid variations in size, due to variations in bronchomotor and/or vasomotor tone. These bilateral changes, more prominent over the affected side, are consistent with such a reflex.

The striking histologic feature of massive collapse is the extreme pulmonary congestion (42–44, 59). This is the outstanding difference in the lung of obstructive and compression atelectasis. It suggests that a vasodilator factor is involved in the initial reflex. Such a vasomotor reflex has been suggested (58, 64, 65). Postural influence may be an associated hypostatic effect, obstruction occurring in the dependent parenchyma because of congestion. Local edema (32)—angioneurotic (43), allergic (66), or due to local irritation (67)—is another factor. The diaphragmatic paralysis of Pasteur (18, 19), accepted by some (42), is for the most part discredited (25, 48, 63). Diaphragm fixation, from pleuritis or trauma, has been mentioned (63, 68–70).

The importance of physiologic atelectasis is recognized (60, 71–73). Posture may influence incidence. Schaack (74) mentions prolonged preoperative hospitalization as a predisposing factor. The reduced vital capacity associated with pulmonary, cardiovascular, and upper abdominal lesions is well known (2). It is a normal postoperative finding in such cases. There is a tremendous variation in vital capacity of even the "normal" patient. Previous pulmonary disease, bronchitis (1), tuberculosis (71), or lung abscess (2), plays a rôle in chest complications. Position of the patient during operation seems important. The dependent side of the chest is predisposed to atelectasis (2, 26, 49, 72, 75–77). Most patients prefer to roll to the right side after laparotomy (58). It is the usual position of comfort. Its effect may not be readily obvious but may be responsible (by intrabronchial spilling, 78) for localization of the atelectasis (59, 63). A thick tenacious sputum is another important factor. Medication, preoperatively and postoperatively, by affecting the respiratory rate, the cough reflex (39, 79–81), the bronchial secretion (82), and the intrapleural pressure (83–85), predisposes to atelectasis. The type of opera-

tion may have a marked predisposing effect (2, 60, 61), but the duration of the procedure and the type of anesthesia (12, 39, 69, 82, 86, 87) are of questionable importance.

Increased incidence during winter and spring has been reported (51, 87) and denied (2). Pasteur (22) reports 12 in 3,559, Scrimger (40) 7 in 540, and Christopher and Shaffer (35) 8 cases in 12,494 operations.

A sudden sharp rise in temperature, pulse, and respiratory rate, with lung findings, occurring twenty-four to seventy-two hours postoperatively, should be considered indicative of atelectasis until proved otherwise. The course may be mild or severe and has been adequately described. The findings are characterized by their variability, only those resulting from change in intrapleural pressure being at all constant. The cardinal roentgenologic signs of collapse are: ipsilateral diaphragm elevation, rib and lung shadow contraction (48), with heart, mediastinum, and trachea displaced toward the affected side. The cardiac displacement[4] is the most characteristic sign of massive collapse. At times this and a slight fever are the only basis for diagnosis.

The atelectasis associated with tuberculosis, enlarged lymph nodes, malignant growth, lung abscess, aneurysm, diphtheria, or the drowned lung of an aspirated foreign body may cause confusion in diagnosis. Pneumonia should be differentiated (9–11, 54). A postoperative chest complication is much more likely to be atelectasis (2). Heart displacement, absence of blood-stained or rusty sputum, lower fever, and pulse rate assist. Differentiation may be extremely difficult (88, 89). Oxygen is helpful in pneumonia but harmful in atelectasis (3). With infarction of heart or lung the patient is kept perfectly quiet; with massive atelectasis frequent postural change is distinctly beneficial. Pneumothorax (1), subphrenic abscess (1), and pleural effusion (71), may be confusing. Pneumonia, lung abscess, or infarction may be engrafted on an atelectasis (2).

Prophylactic and therapeutic CO_2 inhalations (65, 90–97), with frequent change of posture (65, 96, 97) have few dissenters. Pneumothorax (84, 85, 98, 99) is condemned (1, 2, 45, 67). Rolling the patient back and forth on the uninvolved side (49) may be all that is needed; it is simple, logical, and harmless, and should be tried (1, 2, 34, 35). Bronchoscopic aspiration, so dramatic and effective, should be used promptly in resistant cases. Until every surgeon has an expert bronchoscopist as an assistant, however, this will be considered heroic treatment, the immediate prognosis being so favorable with simpler methods.

Farris (99) reports the first recurrence. The patient had a massive atelectasis on the right side after an operation for omental adhesions. A second laparotomy, two months later, was followed by collapse of the right lung. Scott and Joelson (59) report the second instance of recurrence. A patient with massive collapse of the dependent lung following nephrotomy had an atelectasis of the opposite (dependent) lung when the other (left) kidney was operated upon, two and one-half months later. Such cases are important from the standpoint of causative mechanism in postoperative atelectasis. They lend considerable support to the reflex theory. The following case should be of interest.

J. R., age ten, ambulatory, and without significant symptoms or findings except for a mild Froelich's syndrome and associated right cryptorchidism, was admitted to the hospital Aug. 22, 1938. Under ethylene anesthesia, a first-stage Torek operation was done. Operative and postoperative condition was good. Eighty hours after operation the patient became restless, with considerable non-productive cough; temperature 104 per rectum, pulse 120–140, respirations 36–40; white cell count 21,800, polymorphonuclears 92, lymphocytes 8; urine 1.035 and negative. A diagnosis of atelectasis was confirmed roentgenographically. With postural treatment the patient was comfortable and without complaint in

[4] First mentioned by West (100), in 1908. Pasteur (21–23) was confused as to its mechanism at first, but recognized it "as the great clinical sign" in postoperative atelectasis. Elliott and Dingley (25) proved it roentgenologically, and adequately explained it as being due to the greatly decreased intrapleural tension on the involved side, which has since been shown by Elkin (85) and others (83, 84) to be correct.

less than thirty-six hours, although he had a temperature of 101.4° by rectum, pulse 124, respirations 28. All of these gradually returned to normal during the following week. The atelectasis required another two weeks to disappear completely.

The patient was readmitted April 30, 1939. Because of the above history, all known precautions were taken. A complete preoperative physical examination revealed no significant findings. Routine examinations of blood and urine were negative. On May 1, a second-stage Torek operation was performed under ethylene anesthesia. Postoperatively, the patient, being restless, was encouraged to turn from side to side, to cough and raise sputum, and to take deep breathing and arm exercises regularly. Inhalations of CO_2 were given at frequent intervals. Nevertheless, on the fifth postoperative day the patient suddenly displayed a weak, irregular pulse of 140, respirations 48, and a temperature of 103.2°. A diagnosis of atelectasis was made and confirmed roentgenographically a few hours later. Within twenty-four hours the patient was "feeling good"; temperature 99, pulse 112, respirations 28. Again, two more weeks were required for complete disappearance of the atelectasis.

Recently, investigative work on the problem of postoperative atelectasis has been at a standstill. Most writers have simply accepted bronchial obstruction as the primary etiologic factor. Little has been reported regarding the reflex theory (57). Nevertheless, it is authoritatively stated (101) "that when the whole story is known some type of reflex disturbance by way of the sympathetic nerves to the lungs will be the fundamental factor in initiating the pathological change."

The evidence here reviewed and submitted would seem to warrant further investigation of the problem from the standpoint of the vegetative nervous system with a view to vagosympathetic block as a means of preventing postoperative atelectasis, at least in those conditions in which the incidence is high.

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Spontaneous Pneumoperitoneum: A Roentgenologic Sign Found in the Supine Position[1]

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THE IMPORTANCE of the roentgen examination in the diagnosis of perforations of the hollow viscera has been repeatedly stressed and evaluated. In all cases in which a rupture of the stomach, small bowel, or colon, whether of spontaneous or traumatic origin, is suspected, the diagnosis can be made relatively certain by means of roentgen study. The roentgen findings depend upon the occurrence of a spontaneous pneumoperitoneum, gas from the gastro-intestinal tract escaping into the free peritoneal cavity. In all the literature on this subject it has been stressed that it is necessary to have the patient in the upright position in order that the gas may rise to the upper portion of the abdomen, coming to lie just inferior to the diaphragm. Thus the shadow of the gas can be made out by contrast with the diaphragm above and the denser shadows of the solid viscera below. When the upright position is impossible, it has been suggested that films might be made in the left lateral decubitus position, a postero-anterior exposure being undertaken, so that the gas will rise under the lateral abdominal wall and again manifest itself by contrast with the surrounding tissues.

In a series of cases of perforation of the colon from various causes we have observed another roentgen sign of pneumoperitoneum which is particularly valuable because it is manifested in the ordinary scout roentgenograms of the abdomen made with the patient in the supine position. Essentially, this finding consists in the ability to visualize, on the film, the outer as well as the inner wall of the bowel.

It is curious that in the extensive literature on artificial pneumoperitoneum there is no specific mention of this finding, although it has undoubtedly been observed repeatedly. It appears to occur only in those cases in which relatively large quantities of gas and some fluid have entered the peritoneal cavity. Under such circumstances there is a sufficient quantity of contrast medium present to separate the individual loops of bowel from each other. The loops themselves are usually greatly distended with gas because of the peritonitis which is present. As a result, it is possible to observe both the contour of the inner wall of the bowel and of the outer, the thickness of the wall itself being quite apparent. In the ordinary case of ileus it is relatively easy to observe the inner wall of the bowel because of the contrast between it and the gas which distends the bowel. Likewise the thickness of the bowel wall can be approximately ascertained because, with two loops of bowel lying in close juxtaposition to each other, the gas filling each loop delineates its wall; thus the thickness between the two layers of gas ordinarily represents the thickness of both bowel walls. In case of effusion into the peritoneal cavity, the diagnosis can often be made because of the increased thickness of the shadow separating the layers of gas, which results from the entrance of fluid between the two loops. In the case of pneumoperitoneum a different picture is presented. Gas enters in between the two loops so that there is a definite separation by a medium of lower density and the outer limits of the wall of each loop of bowel can thus be delineated. This is practically pathognomonic of pneumoperitoneum and is easily observed in ordinary supine films of the abdomen.

That this finding is not a rare one is indicated by the fact that it was present in five cases of acute perforation of the colon in

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Fig. 1. Case B. B.: Acute obstruction of the colon from carcinoma of the ascending portion; roentgenogram of abdomen (supine position) taken June 9, 1937. The marked distention of the cecum (arrows), indicating the possibility of imminent perforation, the soft tissue mass in the ascending colon (arrow), indicating the position of the obstructing tumor, and the gas-filled dilated loops of small bowel resulting from regurgitation through the ileocecal valve are all well shown. Note especially the appearance of the outer wall of the small intestine (left arrow) and compare with Fig. 2.

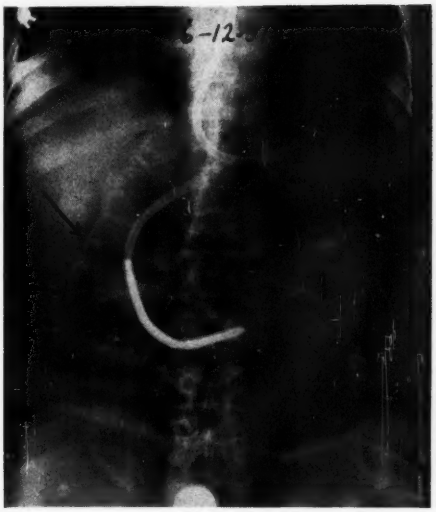

Fig. 2. Same case as Fig. 1; roentgenogram (supine position) taken June 12, after perforation of the cecum. Note the disappearance of the shadow of the colon, with a striking increase in the distention of the small bowel. The outer margins of the bowel loops (arrow) may now be seen owing to the presence of gas about them, producing contrast. The diagnosis of pneumoperitoneum can be made from this film without the use of the upright or lateral decubitus position.

which reasonably satisfactory roentgenograms were obtained with the patient in the supine position. It is perfectly obvious in practically all cases in which artificial pneumoperitoneum is undertaken. We have observed it in a number of patients in whom a perforated ulcer of the stomach occurred and in whom unusually large amounts of gas were present. In perforations of the upper intestinal tract, because the quantity of gas which escapes is commonly small, this sign is frequently absent and it becomes necessary to make films in the upright or lateral decubitus position in order to determine the diagnosis more definitely. In the case of perforations of the colon, however, much larger amounts of gas are extruded, so the sign is usually present.

The importance of this finding lies in the fact that in many instances, particularly in the case of acute obstruction of the colon which is being treated conservatively, the onset of the perforation may be difficult to determine by the clinical findings. Many of these patients are extremely ill because of the obstruction and because of the nature of the lesion which is producing it. During the period of treatment their clinical findings may change relatively little after the onset of the perforation. Frequently, of course, there are evidences of collapse, but because of the serious condition of the patient preceding the catastrophe it may escape clinical detection. In most instances in which acute obstruction of the gastro-intestinal tract is being treated conservatively, routine bedside films of the abdomen with the patient supine are being made. Certainly they should be undertaken at regular intervals to determine the degree of distention of the intestinal tract, if for no other reason. Careful examination of such routine films may reveal the super-

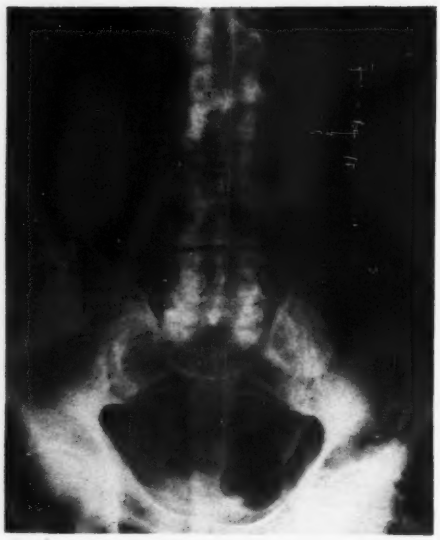

Fig. 3. Case of perforation of the colon with pneumoperitoneum; roentgenogram of abdomen, supine position. Note the distended loops of small bowel, both their inner and outer contours (arrows) being readily visible.

Fig. 4. Case A. S.: Spontaneous pneumoperitoneum of unknown origin, without symptoms of peritonitis; roentgenogram of right upper quadrant of abdomen, supine position. Note the distended loops of small bowel, the outer walls of which (arrows) are clearly visible. The diagnosis of pneumoperitoneum is obvious despite the supine position and the local area of the abdomen which was examined.

vention of perforation and peritonitis and this may furnish the first evidence indicating the necessity for more radical treatment.

To illustrate such a sequence of events the following case is reported:

Mrs. B. B., aged 73, was admitted with evidences of obstruction of the bowel, which had been present about five days. The roentgenographic examination of the abdomen (Fig. 1) revealed a dilated cecum with a soft tissue mass in the region of the ascending colon, suggesting strongly the presence of an obstructive process at this point, producing a tumefaction. There were a number of loops of small bowel, also distended with gas, probably owing, in this instance, to regurgitation through the ileocecal valve. This does occasionally occur, although it is uncommon in obstruction of the colon; it may have occurred in this instance because the obstruction was so close to the valve itself. Distention of the cecum was of marked degree. For various reasons suction treatment was instituted and conservative treatment was considered. Routine films of the abdomen were made at intervals of twelve hours. Seventy-two hours later some change in the patient's condition occurred, but she had been so seriously ill prior to this that the change was not clearly observed. The roentgenogram taken at this time, however, showed a very striking alteration (Fig. 2). The loops of small bowel were greatly distended. The cecum was no longer observed, no doubt having been deflated. The wall of the small bowel is clearly visible in this film (arrow) both from within and without. A distinct separation of the loops from each other and from the remainder of the abdomen is made out, indicating the presence of some contrast material around the loops, of a density less than that previously observed. The diagnosis of perforation with spontaneous pneumoperitoneum and peritonitis was immediately suggested. Upright films of the abdomen were made and these confirmed the presence of large quantities of gas and fluid in the peritoneal cavity. The patient was submitted to exploratory laparotomy immediately and the findings described were confirmed. There was a perforation of the cecum which permitted the escape of gas and fluid in the peritoneal cavity. The patient later succumbed.

This case illustrates the importance of repeated routine examination of the abdomen and the value of the observation of this sign in the early diagnosis of a spontaneous pneumoperitoneum from perforation.

A case of a similar type is illustrated in Figure 3. Here again there was a perforation of the colon and the markedly dis-

tended loops of small bowel with the outer wall clearly visible are again shown. The diagnosis likewise was confirmed when films in the upright position were made.

That spontaneous pneumoperitoneum is not always productive of clear clinical symptoms is illustrated by the following case.

Mr. A. S., aged 78, came in complaining of dysentery, gaseous distention, and vomiting, of four years' duration. He was seen in the Out-Patient Department, neither prostrated nor particularly toxic, and the clinical impression was possible cholecystitis. While the abdomen seemed tympanitic on percussion, this was thought to be from gaseous distention of the intestines. The patient was referred for x-ray examination of the gallbladder. The film of the gallbladder region is shown in Figure 4. It was made in the usual postero-anterior prone position, and again the outline of the loops of small bowel is clearly observed in the right upper quadrant. Despite the local area of the abdomen which appears in the roentgenogram, the diagnosis of pneumoperitoneum is obvious at once. Further studies in the upright and lateral decubitus positions confirmed the presence of large quantities of free air in the peritoneal cavity. The origin of this air was never determined. The patient was seen for four days, during which the pneumoperitoneum persisted without further untoward symptoms. He then disappeared and the final outcome remains in doubt.

This case is cited to illustrate the fact that careful observation of roentgenograms of the abdomen, made in the supine position, may indicate the presence of pneumoperitoneum in the absence of symptoms, despite the failure to obtain upright or lateral decubitus films.

SUMMARY

A roentgenologic sign of pneumoperitoneum hitherto not reported or clearly defined is described. It consists of the demonstration of the outer as well as the inner bowel wall due to the accumulation of gas between the loops of bowel. It is of value because it can be observed in roentgenograms of the abdomen made in the supine position.

This sign may be the first evidence of the presence of pneumoperitoneum in cases in which such a condition is entirely unsuspected. Routine roentgenograms of the abdomen should be made at frequent intervals in all cases of obstruction of the gastro-intestinal tract which are being treated conservatively. Such films should always be examined for evidences of pneumoperitoneum because of the possibility of supervention of perforation without obvious clinical signs.

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The Influence of Roentgen Irradiation of Normal Lung on the Prevention of Subsequent Metastatic Tumor Growth: Preliminary Report[1]

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THE PROBLEM OF natural and acquired immunity to cancer has been extensively studied during the past fifty years. It is an established fact that such an immunity exists against transplanted animal tumors (2, 4, 8, 12, 14), although its existence in the case of spontaneous tumors is more difficult to determine. Studies in the heredity of cancer would indicate that natural immunity occurs in both animals and man. Wood (25) has stated, however, that there is no evidence that regression of spontaneous tumors in man, at least, depends upon any process of acquired immunity.

The mode of the production of natural and acquired immunity to transplantable tumors and their metastases in experimental animals has not been determined. Ewing (10), in 1922, called attention to the influence of the tumor bed in the establishment of metastases. Loeb (18) thought the local tissue defense against cancer was essentially a foreign-body reaction. Growth-inhibiting factors in normal serum have been postulated by Carrel (6). Hektoen (13) believed antibodies against foreign cells were formed in the bone marrow. It has never been possible, however, to transfer immunity from one animal to another by any method using serum or normal cells or their products (2, 12, 15).

Several writers have believed the defense against cancer a function of the so-called "reticulo-endothelial system." In 1932 Foulds (11) indicated the protective rôle of these cells in preventing splenic metastases in animals inoculated with the Brown-Pearce rabbit carcinoma. Arons and Sokoloff (1) in a recent paper reviewed the literature on this subject, adding material, both experimental and clinical, to support their contention that susceptibility to cancer can be altered by stimulating or depressing the reticulo-endothelial cells throughout the body.

The existence of a circulating cellular defense against neoplastic tissue has been the subject of much debate. Kardjiev (14) in 1937 described an overwhelming lymphocytic reaction about abortive metastases in the lungs of rabbits immunized against the Brown-Pearce tumor. Previously, Murphy and his co-workers (16, 17), Russ and collaborators (21), and Clarkson and Mayneord (9), all had developed experiments indicating that the circulating lymphocyte played a definite rôle in the immune reaction. This view, however, was opposed by Prime (20) and Sittenfield (24), who were unable to duplicate the experiments which led to it.

Brown and Pearce (3, 4, 5) and Casey (8) working with the Brown-Pearce rabbit carcinoma were content to ascribe immunity to some constitutional factor as yet unknown.

The phenomenon of the resistance of certain organs to metastases is an important part of the general concept of cancer immunity. It is well known that in most animals, and in man, the spleen is rarely involved by secondary epithelial neoplasms (11). Conversely, in certain tumors the predilection of metastases for special organs has become a pathological commonplace. Mention need be made only of the pulmonary metastases from osteogenic sarcoma and the osseous metastases from carcinoma of the breast, as illustrations. As early as 1911, Sittenfield and Levin

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(23) thought this selectivity of metastases due to a chemical "affinity" between the organ of the host and the cancer cell. Others have attempted to explain it by variations in the local anatomy of the arterioles and capillaries leading to preferential thromboses of tumor material. An admirable summary of the various theories concerning the selectivity of metastases is to be found in a recent book by Willis (26).

Many attempts have been made to alter both the resistance of the whole organism and the resistance of local organs to carcinoma. Murphy (17), Russ (21, 22), and Loeb (18) established the fact that small doses of x-rays have a protective action against subsequent tumor implantations in the skin and subcutaneous tissues. These authors believed that the irradiation increased the local tissue resistance against cancer cells. Wood (25), on the other hand, has maintained that this apparent increased resistance to tumor inoculation is due to changes in the blood vessels subsequent to irradiation, which render the field unsuitable not only to cancer implants but to any tissue graft. He believes that failure of tumor implants to grow is not due to any local immunity against cancer in the sense that the host's cells have acquired a particular resistance to neoplastic tissue.

Because the literature dealing with cancer immunity is still controversial, it was decided to study further the problem of the localization of metastases, and to inquire whether the susceptibility of an organ to metastases from a given tumor could be altered by roentgen irradiation.

METHOD

The tumor used in this study was the Brown-Pearce rabbit carcinoma, which grows rapidly, metastasizes widely, and is easily transplanted. Its characteristics have been thoroughly studied by its discoverers (3, 4, 5) and by Casey (8). The experimental animals were young adult stock rabbits of the New Zealand white strain. A few of the later animals used were a cross between this strain and the Belgian hare. All except one of the experiments were performed with males, since the tumor is more easily transplanted intratesticularly. In rabbits of this stock, four to eight weeks after tumor implantation, the lungs present microscopic metastases in about 80 per cent, and macroscopic metastases in about 30 per cent of animals.

Fig. 1. Gross specimen of both testes of a rabbit six weeks after intratesticular inoculation. Tumor has completely replaced normal tissue on both sides. Compare the size with that of a normal testis shown above.

Groups of rabbits received roentgen irradiation to the right lung and were subsequently inoculated with the tumor intratesticularly. The irradiation was delivered anteriorly through a port 10 × 5 cm., the rest of the animal being protected by sheet lead. The other constant roentgen factors were: effective wavelength 0.382 A°. (about 120 kv.) with 4 mm. Al filtration and 5 ma. current. This was delivered at the rate of 78 roentgens per minute at 20 cm. distance. With radiation of this quality, 50 per cent of the dose is absorbed at 4 cm. beneath the surface of solid tissue (19). As the average rabbit meas-

ured 7 to 9 cm. through the chest, probably more than half the radiation was absorbed by the time the beam emerged from the air-filled lung. The quantity of radiation varied from 300 to 900 roentgens. Some groups of animals received a single dose. In others the dose was divided and given in daily or two-day intervals. In most of the rabbits the tumor was inoculated within ten days after the last dose of roentgen rays. Those animals which did not die as a result of the tumor were killed two to four months after inoculation.

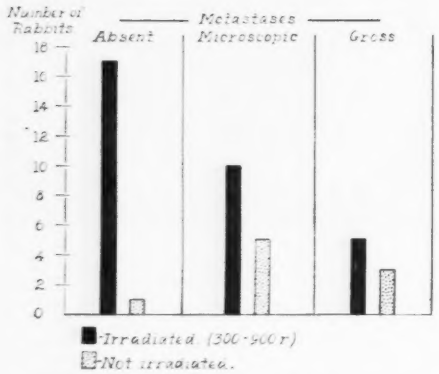

Fig. 2. Effect of roentgen irradiation on pulmonary metastases. This graph demonstrates the apparent protective effect of irradiation in preventing metastases. Note that of 6 animals receiving no irradiation before tumor inoculation 5 had pulmonary metastases. On the other hand, of 27 animals irradiated before tumor inoculation only 10 had pulmonary metastases.

RESULTS

Thirty-four rabbits were used in this experiment. Six of these received tumor inoculation and no irradiation and served as controls. Two others died immediately after tumor inoculation from irrelevant causes. Twenty-six animals were irradiated as described above and subsequently inoculated with living tumor.

About 90 per cent of the inoculated tumors continued to grow locally for many weeks, some to huge size (Fig. 1). The incidence and distribution of metastases in the control animals were about as found by Brown and Pearce (5) and Casey (8). Of the rabbits not irradiated, 80 per cent

Fig. 3. Heart and lungs of a rabbit five weeks after intratesticular inoculation with Brown-Pearce rabbit carcinoma. No irradiation was given. Note the numerous large metastatic nodules in both lungs and the solitary nodule in the pericardium.

showed microscopic pulmonary metastases. In the irradiated group such metastases occurred in 35 per cent of animals (Fig. 2). The gross and microscopic features of the pulmonary metastases are shown in Figures 3, 4, and 5. Although the quantity of radiation received varied in different groups of rabbits, all the groups showed a similar reduction in the incidence of pulmonary metastases. When metastases did occur, however, they were equally distributed in the right and left lung.

The time at which the irradiation was received appeared to have some influence on the prevention of metastases. Of 19 rabbits inoculated within one week after the last dose of roentgen rays, 10 had microscopic pulmonary metastases. Of 7 animals inoculated later than one week after the last dose of irradiation was given, 1 had microscopic pulmonary metastases (Fig. 6).

In addition to the apparent protective effect of irradiation on the lungs, several unrelated and incidental observations of interest were noted during this study. Four animals developed permanent immunity after regression or removal of the primary tumor. The testis is normally the most favorable soil for implantation of this neoplasm. In these 4 rabbits, however, repeated intratesticular inoculations failed to grow. Heavy doses of irradiation were applied over the testis in an attempt to

Fig. 4. Microscopic section of lung taken from specimen in Fig. 3. Note the large peribronchial carcinomatous nodule. The dark areas in the growth are due to cornification and necrosis. There is no lymphocytic reaction about the margins of the tumor.

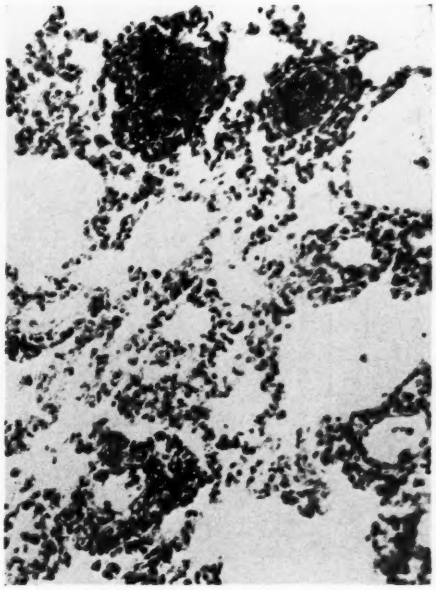

Fig. 5. Microscopic section of lung of a rabbit, six weeks after intratesticular inoculation of Brown-Pearce carcinoma; 312 roentgens were given three days before inoculation. Below are two small blood vessels containing no tumor but with a number of lymphocytes around them. Above are two vessels containing obturating thrombi of tumor cells. Numerous lymphocytes are clustered about them, but the vessel walls are interposed between the growth and the lymphoid tissue. This would seem to indicate that the perivascular collection of lymphocytes is a normal finding and did not arise in response to the presence of the tumor.

weaken the acquired immunity, but without success.

In animals dying with widespread metastases the constant freedom of the spleen was a striking finding. In 20 rabbits with transplanted primary tumors grown to large size and secondary tumors in one or more locations in the body, careful examination of gross and microscopic specimens showed no metastases in the spleen.

Practically no cellular reaction was found about tumor nodules in the lungs (Figs. 4 and 5). Intravascular growths were seen with perivascular collections of lymphoid tissue about them. These collections did not appear to exceed in size the regularly distributed perivascular lymphoid nodules about vessels in which there were no neoplastic growths. Some of the rabbits, however, with local testicular tumors and no pulmonary metastases seemed to have an unusual amount of lymphoid tissue in the sections of the lung examined.

Eight rabbits were prepared by Casey's method of stimulating metastases by the previous injection of frozen tumor tissue (7). Of these, 4 showed microscopic and 2 showed gross pulmonary metastases. This incidence was not significantly higher than that in the 24 animals with no previous preparation (11 microscopic and 5 gross metastases).

The appended table contains complete data on each of the animals used in this experiment.

DISCUSSION

It should be stated at the outset that this is in the nature of a preliminary report. There are so many variable factors in a study of this kind that a much larger group of animals is necessary to furnish reliable conclusions. In the light of pre-

TABLE I: DATA ON THE EXPERIMENTAL ANIMALS USED IN INVESTIGATING THE INFLUENCE OF IRRADIATION IN THE PREVENTION OF METASTASES

Rabbit	Date and Site of Inoculation	Progress	Weeks before Death	Amount of Radiation	Interval between Irradiation and Inoculation, Days	Gross Pulmonary Metastases	Microscopic Pulmonary Metastases	Remarks
2	1/10 i-test.	+		.....				Control. Immune
	3/10 i-test.	0		.....				
	3/28 i-test.	0		312 r × 2	7 and 1	0	0	
	4/30 i-test.	++ 0		.....				
1	12/20 i-test.	++++	6	.....	...	0	+++	Control. Overwhelming metastases. Spleen negative
1a	1/26 i-test.	++++	4	.....	...	+++	+++	Control. Equal distribution. Spleen negative
39	11/18 i-test.	++++	8	.....	...	0	+++	Control. Prepared with frozen tumor first. Equal pulmonary metastases
40	11/18 i-test.	++++	5	.....	...	+++	++++	Control. Preparation with frozen tumor first. Overwhelming metastases. Equal distribution
41	11/18 i-test.	++++	9	.....	...	0	+++	Control. Preparation with frozen tumor first. Overwhelming lymphatic metastases. Spleen negative
3	2/15 i-test.	++++	6	312 r	3	0	++	Equal metastases. Spleen negative
4	2/15 i-test.	++++	6	312 r	3	0	++	Equal metastases. Spleen negative
5	2/23 i-test.	++++	4	312 r	4	++	+++	Equal metastases. Spleen negative
6	2/23 i-test.	++++	4	312 r	4	0	0	Abdominal tumors. Spleen negative
20	3/10 i-test.	+++ 0		312 r	3	0	0	Immune
	4/21 i-test.	++ 0		.....				
	11/ 9 i-test.	0						
22	3/10 i-test.	+++ 0		312 r	3			Unusual amount of lymphoid tissue in lungs. Local tumor only
	4/21 i-test.	++ 0		.....	...	0	0	
	10/ 9 i-test.	++++	5	.....				
9	5/ 3 i-ven.	0	1	312 r	1	0	0	Sudden death 1 week after inoculation. Autopsy negative. No difference between irradiated and other lung
38	9/ 3 i-test.	++ 0		308 r	5			
	10/ 9 i-test.	++++	6	.....	...	0	+++	Equal metastases. Spleen negative
26	4/16 i-test.	++++	8	312 r × 2	4 days after	++	++	More metastases on right? Spleen negative
33	9/ 3 i-test.	++++	5	308 r × 2	5	0	0	Preparation with frozen tumor first. Only local tumor
34	9/ 3 i-test.	+ 0		.....	...			
	10/ 9 i-test.	0		.....	...	0	0	Preparation with frozen tumor first. Immune
	11/ 9 i-test.	0		308 r × 2	5			

34	9/ 3 i-test.	0		.....	...			
	10/ 9 i-test.	0		.....	...	0	0	Preparation with frozen tumor first. Immune
	11/ 9 i-test.	0		308 r × 2	5			

TABLE I: DATA ON THE EXPERIMENTAL ANIMALS USED IN INVESTIGATING THE INFLUENCE OF IRRADIATION IN THE PREVENTION OF METASTASES (*cont.*)

Rabbit	Date and Site of Inoculation	Progress	Weeks before Death	Amount of Radiation	Days between Irradiation and Inoculation	Gross Pulmonary Metastases	Microscopic Pulmonary Metastases	Remarks
35	9/ 3 i-test.	++ 0		.....	...			Preparation with frozen tumor first. Overwhelming metastases. Spleen negative
	9/25 i-test.	++++	8	308 r × 2	5	+++	++++	
37	9/ 3 i-test.	+ 0		.....	...			Preparation with frozen tumor first. Equal metastases. Spleen negative
	9/25 i-test.	+++	5	308 r × 2	5	0	++	
29	6/21 i-ven.	+ 0		.....	...			
	6/21 i-test.							
	7/ 7 i-test.	++ 0		.....	...			
	10/ 9 i-test.	+ 0		.....	...			Unusual lymphoid hyperplasia in lungs. Local tumor only
	11/ 9 i-test.	+++	25	234 r × 3	30	0	0	
30	6/21 i-ven.	++ 0		.....	...			Immune. Used to investigate amount of lymphocytic reaction about abortive metastases
	6/21 i-test.							
	10/ 9 i-test.	++ 0		.....	...	0	0	
	1/14 i-test.	+		234 r × 3	14			
31	7/ 7 i-test.	+++	11	234 r × 3	8	0	0	Preparatory injection with frozen tumor. Large abdominal tumors. Spleen negative
32	.....		1	234 r × 3	1			Killed by overdose of nembutal before inoculation. No difference in irradiated and other lung
28	5/16 i-test.	++	1	780 r	2	0	0	Died rapidly of paralysis. Spleen negative
27	5/16 i-ven.	++	2	780 r	2	0	+	Bone metastases. Spleen negative
10	5/ 3 i-ven.	++	6	780 r	1	0	0	C. N. S. metastases. Spleen negative
11	4/30 i-ven.	0	8	780 r	10	0	0	No metastases or localized tumor
	4/21 i-ven.	0						
12	4/21 i-ven.							Metastases to eye. Equal pulmonary metastases. Spleen negative
	4/30 i-ven.	+++	7	780 r	10	0	++	
19	3/28 i-test.	++++	2	312 r × 3	1 day after	++	+++	Equal pulmonary metastases. Spleen negative
21	3/28 i-test.	++++	4	312 r × 3	1 day after	++	++	Equal pulmonary metastases. Spleen negative
23	4/21 i-test.	++++	9	312 r × 3	6 days after	0	0	Only local tumor
24	4/17 i-test.	+ 0		.....	...			
	5/16 i-test.	++	16	312 r × 3	19	0	0	Only local tumor
25	4/17 i-test.	+ 0						
	5/16 i-test.	+++	8	312 r × 3	19	0	0	Only local tumor
36	9/ 3 i-test.	0						
	9/25 i-test.	+++	5	308 r × 3	5	0	0	Preparation with frozen tumor first. Only local tumor

vious knowledge, however, the material of this study indicates some interesting trends.

In the first place, it appears that radiation, in the amounts used, played some part in preventing pulmonary metastases in rabbits subsequently inoculated with the Brown-Pearce carcinoma. This effect occurred not only in the right lung, which was irradiated, but also in the left lung, which was covered with lead. Either the lead did not protect the left lung as expected or the effects produced in the right lung were transferred to the left lung *via*

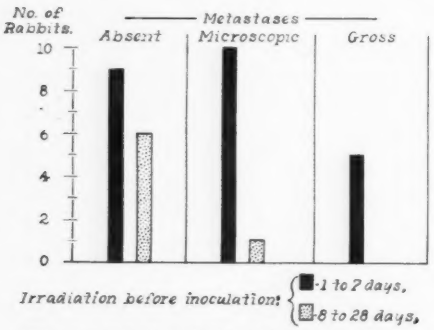

Fig. 6. Relation of time of roentgen irradiation to pulmonary metastasis. This graph demonstrates that a time interval is necessary between irradiation and tumor inoculation if protection against metastasis is to be obtained. Note that of 19 animals inoculated with tumor within one week after the last dose of roentgen rays, 10 had pulmonary metastases. On the other hand, of 7 animals inoculated with tumor two to four weeks after the last dose of roentgen rays, only 1 had metastases.

body channels. Since the thorax of the rabbit is a relatively small volume of tissue, it is reasonable to assume that sufficient scattering of radiation under a port 10 × 5 cm. would occur to contribute a large proportion of the incident dose to the protected side.

In addition to the lessened incidence of pulmonary metastases after irradiation, there seemed to be a general diminution in the size and number of metastases to other organs. However, complete data on the incidence of metastases in all organs were not kept, since this aspect of the problem is to be more fully studied in a subsequent investigation. The present experiments are concerned with the local, rather than the general, effect of irradiation on the prevention of metastases.

Regardless of the quantity, the time at which the radiation was given appeared to have some relation to the incidence of pulmonary metastases. If it was given within one week before inoculation of the tumor, about half the animals developed metastases (10 out of 19). If it was given two to four weeks before inoculation, 1 animal out of 7 developed metastases. It would seem that any effect produced by the irradiation is a delayed one, with a time interval similar to that occurring after irradiation of normal skin.

Aside from the effects of irradiation on the development of metastases, several incidental observations are worthy of note. The few animals which developed permanent immunity after removal or regression of the primary tumor raise many questions which lie outside the scope of this paper. The contributions of Besredka (2), Gross (12), and Kross (15) to this subject have already been mentioned. In contrast to this general immunity, local organ immunity was also encountered in the spleen. The unique freedom of the spleen in the presence of widespread metastases was a remarkable and consistent finding. This is in agreement with the very low incidence of splenic metastases described by Brown and Pearce (4, 5) in their original study of this tumor. Further investigation of this phenomenon with Foulds' work (11) as a basis might be of great value.

The question of a circulating cellular defense in the immune state has not been directly investigated. In all sections of lung, however, which showed any microscopic evidence of tumor, the malignant nodules were consistently free of infiltration with either lymphocytes or polymorphonuclear cells about their borders. Occasional leukocytes were found in the necrotic centers of large tumors. On the other hand, in at least two animals showing, after many weeks, degenerating primary tumors and no metastases, all sections

of lung contained an unusual amount of lymphoid tissue. This suggests the observation of Kardjiev (14) that overwhelming lymphocytic reaction occurred about abortive tumor nodules.

A word may be said in regard to the so-called "Duran-Reynals-like reaction," recently the subject of several communications by Casey (7). In his hands it was found that among rabbits inoculated with bits of frozen tumor tissue and later inoculated with living tumor in the usual way, larger local tumors and more rapid metastases developed, in a greater number of animals, than among those not so prepared. This was believed to show a specific weakening of the host's natural immunity presumably caused by a Berkefeld-filter-passing substance liberated from the frozen tumor tissue. This procedure was followed in the preparation of a few animals in the present experiment. Those upon whom it was tried showed no significant difference in susceptibility to the primary inoculation or subsequent metastases as compared with animals not so treated.

CONCLUSIONS

1. Moderate doses of radiation (300–900 roentgens) appear to lessen the incidence of pulmonary metastases in rabbits subsequently inoculated with the Brown-Pearce carcinoma.

2. Radiation appears to be most effective in preventing pulmonary metastases of Brown-Pearce carcinoma if given two to four weeks prior to tumor inoculation.

3. There is no definite cellular reaction about the metastatic tumor nodules in the lungs, whether radiation has been given or not.

4. A small proportion of rabbits develop permanent immunity after removal or regression of the primary tumor.

5. In the few animals previously prepared by injection of frozen tumor material after the method of Casey, there was no evidence of an increased susceptibility to the tumor or its metastases.

Grateful acknowledgment is due Dr. Samuel R. Haythorn, Director of the William H. Singer Memorial Research Laboratory, for interpretation of the microscopic sections, help in obtaining the photographs, and criticism in the formulation of the material for this paper. Thanks are also extended to Dr. John Ungar, Jr., and Dr. Elwyn L. Heller of the same laboratory for their aid in portions of this study.

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A Simplified Method of Preserving Radiographs and Allied Records on Miniature Film[1]

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THE COPYING OF radiographs on miniature film is an outgrowth of the development of the 35-mm. camera and satisfactory recording media. The advantages of such records need not be enlarged upon here. The amount of space necessary for the storage of old films and the disappointment of discovering that a desirable film has been discarded are experiences common to all radiologists.

Reproductions of radiographs for lantern slides, illustrations, and exhibits are produced with varying degrees of success, failures being due to poor originals, lack of knowledge of the principles involved, or inherent difficulties in the particular recording medium selected. For some time radiographic quality has been improving through the use of finer focus tubes, better radiographic equipment, and a spreading interest in a uniform and more satisfactory technic. Meanwhile film manufacturers have developed new emulsions for photography with wide latitude, whereby satisfactory reproductions of radiographs may be obtained.

Present experimental work with the "fluorograph," on both 4 × 5 and 35-mm. film, and the modern method of condensing records, newspapers, manuscripts, checks, etc., on microfilm for preservation in greatly reduced bulk, suggested a possible combination of the two for application to radiographs. This method as adapted to large numbers of films and employed commercially has been recently reported by Siegel (1).

In reproducing radiographs photographically there are several basic principles which must be kept in mind. Each step in the reproducing process increases contrast, that is, when the positive copy is made from the original radiograph, contrast is increased; when this is again reproduced as a negative, further contrast is introduced. Thus it is of prime importance to reduce the number of steps which must be taken to obtain the final copy. There is available at present a fine grain reversible film[3] which eliminates one step in that the original copy exposure is reversed in the developing process.[4] As detail is lost, also, with each step in the copying process, the

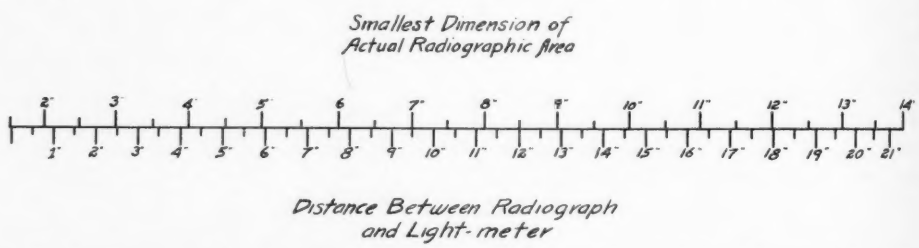

Fig. 1. Exposure scale. The upper figures on the scale represent the actual size of the recorded area to be copied. The lower figures indicate the distance at which the exposure meter must be held from the center of the radiograph, assuming the meter has a 30° acceptance angle. If, for example, the radiograph has a circular area 12 inches in diameter (upper scale), the light meter must be held 18 inches away from the center of the illuminated film (lower scale) when calculating copying exposure. With square radiographs, measure one side, and with rectangular radiographs measure the short side and proceed as outlined above.

[1] Accepted for publication in March 1941.

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[3] "Superpan reversible," manufactured by Agfa Ansco, Binghamton, N. Y.

[4] Because this film is of the reversible type, it is processed by the manufacturer in strategically located reversal laboratories.

single-step method is preferable from this angle.

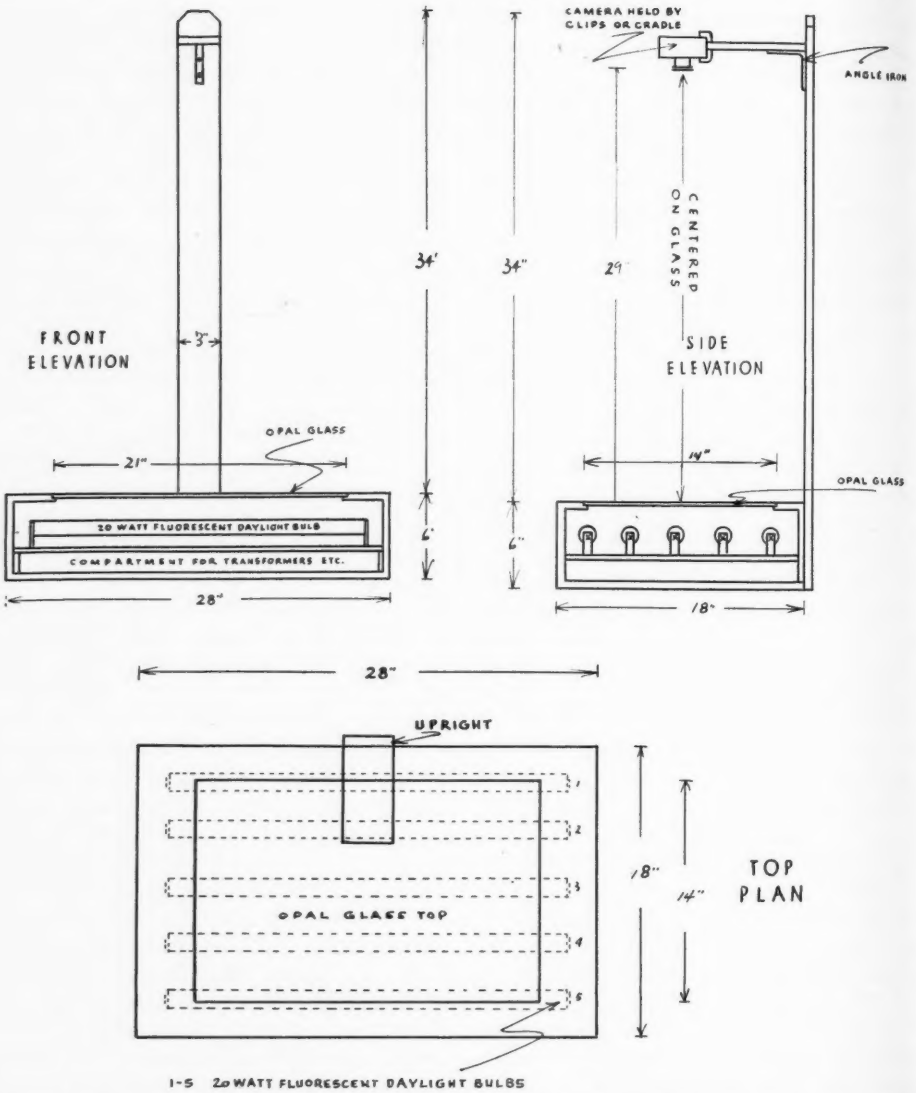
The proper exposure must be determined with care, by means of a highly sensitive photoelectric exposure meter. It is obvious that the amount of light transmitted by a 14 × 17 film of an extremity will be much less than by a film of the chest of similar size, and yet the actual light coming through the parts of interest may be the same, and for the proper effect each should have the same exposure. This problem has been carefully studied and a scale (Fig. 1) worked out. This scale is based on the angle of light intercepted by a Weston exposure meter. The upper figures represent the narrow measurement of the part of interest on the film; the lower, the distance at which the meter should be held to obtain the proper reading.

A simple apparatus can be built with variable factors reduced to a minimum. Once it is set up, anyone can operate it even though lacking technical knowledge of photography. The camera used must focus at three feet or less, or an auxiliary lens must be used. The distance between the camera and light source should be determined so that the camera frame covers an area 14 inches × 21 inches. This may be done with sufficient accuracy by fastening two tape measures on the wall in the form of a cross. The camera is adjusted to the shortest focal distance possible and a relatively small aperture used; f8 or 11 will be satisfactory for cameras which focus at 2.5 to 3 feet. With the camera at a distance of 2 feet from the tapes, and centered where they cross, an exposure is made. The camera is now moved backward 2 inches, and another exposure is made. This is repeated until the camera is 3 feet away. The object-camera distance will vary somewhat for cameras of different makes but will be approximately 30 inches. The sharpness of focus is tested at the same time; if it is found that unsharp reproductions are obtained, an auxiliary lens should be used. In this event the object-camera distance must be checked.

The author's equipment (Figs. 2, 3, and 4) consists of a wooden box 28 × 18 × 6 inches, painted white inside, holding five 20-watt daylight fluorescent tube lamps. Centered in the top is a piece of flashed opal glass 14 × 21 inches. This produces a uniform light source of 200 foot-candles at the surface of the glass. The camera is supported so that the lens is 29 inches above the center of the glass, and is held to the cross arm by a pair of clips or a cradle so that it is readily removable for changing film and yet can be accurately replaced.

The depth of focus appears to be greater than indicated by camera manufacturers, as openings as great as f3.5 result in fairly sharp reproductions at a distance of 29 to 30 inches. It is better, however, to use f5.6 or smaller openings.

Identification of films is readily accomplished by utilizing the space at one end of the opal glass. As the frame of a 35-mm. camera covers an area of 14 × 21 inches, there will be an unused space of 14 × 4 inches, on which may be written the number, date, and other desired data with a china- or glass-marking pencil; or large opaque figures and letters (as the common lead markers for radiographs) may be used. This is the simplest method of identification, as it is recorded when the film is exposed. It is necessary only to change the last figure, and occasionally the date, with each succeeding film. If all radiographs are marked by lead letters that are plainly visible, no further identification is required. This is seldom the case, as many times the letters lie in heavily blackened or very light areas. Another excellent method of identification is to stencil the number and date in the film with a stencil-cutting machine. Even in a white area the amount of light coming through the holes in the film is greater than that through the film itself, so that the inscription becomes plainly visible on the copy. Other methods using reflected light, such as first exposing a corner of the envelope, the index card, or a card on which the desired data are typed, can be used. For this method of identification, it is essential that only the area of the card be illuminated. This is difficult



Figs. 2–4. Author's apparatus for reproduction of radiographs. The distance between camera and illuminating box will vary with the make of camera.

and can be accomplished satisfactorily only by using a spot light with a mask to throw a rectangular beam of light on the card. If more than this area is illuminated the part of the film for the radiograph is fogged. After exposing for the label, the film is again exposed for the radiograph. With many of the modern miniature cameras this double exposure is impossible unless a time exposure is used, and with the apparatus above described exposures are rarely longer than one second even with the camera stopped down to f32, unless the radiograph is very dense.

Still another method, and probably the least satisfactory, is to keep a written record of each radiograph in order of exposure, this record to be filed with the roll of

film. In this case each roll of film would need a separate identifying number exposed on the first frame identical with that of its record. This method is open to the greatest error, and furthermore the written record is likely to be lost.

Many problems will be encountered in running through a routine series of radiographs. Films of only fair diagnostic quality will reproduce well, and often the general appearance of a radiograph is improved because of the increase in contrast. If the original is of poor quality, little can be done, since detail is already lacking. Thin radiographs reproduce better than overexposed ones. The latter, and those already showing considerable contrast, should be slightly overexposed in copying. This tends to decrease the excessive contrast, which may be built up in the copying process.

Several small radiographs of the same case may be placed together to make up the copy-flat and exposed simultaneously provided the amount of light transmitted by the individual films does not vary more than 100 per cent between the lightest and densest ones; the latitude of the film takes care of this difference. An exposure time midway between the extremes should be used. For example, if the lightest film requires an exposure of half a second at f16, the densest film would need not more than one second and the actual exposure should be three quarters of a second. In instances where there are many radiographs for a single case, some may be eliminated, and only the important ones recorded. Great care should be exercised in the choice, and all different views or areas included. Only obvious duplicates or extremely poor films should be eliminated. To expedite the process the radiographs to be copied should be selected in advance of the actual copying process and placed in the proper order. This will eliminate errors and add to the efficiency.

To utilize fully the available storage space for radiographs of regular size, it is desirable to plan a regular routine, such as a weekly or monthly run of reproductions, emptying out the regular radiographic storage space just enough to keep ahead of new films coming in, thus fully utilizing this space at all times. Making reproductions periodically and on schedule will relieve undue strain on personnel arising from hurried work done at infrequent and irregular intervals.

A number of objections may be raised to this form of record. I believe these are largely overestimated.

Loss of Detail: There is a slight loss of detail, most noticeable in the case of small or faintly visible lesions, the most obvious examples being early tuberculosis, faint shadows of gallbladder or kidney calculi, minor changes in bone, etc. I believe this disadvantage is not as important as it might seem. At least, it may be offset by referring to the original interpretation. Furthermore, a small lesion such as early tuberculosis will become a definite shadow on subsequent films long before the original is destroyed.

The usual reason for desiring films of five or more years past is for comparison in some relatively obvious pathological condition, as to determine change in heart size or shape, or the exact location and type of an old fracture, or to follow changes which require a long time to develop, as in slowly growing tumors and certain deformities and diseases of bone. Acute lesions, or those apt to be controversial or of small size, are usually definitely diagnosed before the originals must be discarded. In addition, in cases of unusual interest, or of controversial nature, or involved in a medico-legal dispute, the films would, or at least *should*, go in a special file.

Loss of Size: This objection is overcome by standardizing the size of the reproductions by fixing the object-camera distance, and is the main reason for making all exposures at the same distance and thus to the same scale. By standardizing projection, the small films are returned to their original size and actual measurements of size, angles, etc., may be readily and accurately made.

Voluminous Cases: The procedure to

follow in those cases in which many films have been taken will have to be determined for the individual case. Some of these will go in special files, others will be carried forward. Those which are not will require either full reproduction or illustration by reproduction of outstanding features. In fracture cases the most important films are the first and last, with an occasional interval film to illustrate important changes.

Viewing: As with any new method of procedure, "practice makes perfect," and one soon learns to interpret small reproductions readily. Projection is the best method, as any number of people may view the film at one time and the film may be enlarged to any desired size, or a standardized projection method as above outlined may be used. Only one film, however, may be viewed at a time unless a hand lens is used in place of the projector to examine several films in quick succession.

When one considers the tremendous advantage of being able to store some 800 reproductions in a can only 4 1/8 × 1 3/4 inches in size, the small cost of making reproductions, and the possibility of enlarging the scope of usefulness of radiology, any possible disadvantage sinks into relative insignificance. So many applications flood the imagination that they seem without end.

The method of storing may be suited to individual taste. The film for 35-mm. cameras is sold in lengths of 36 exposures. This is returned after development in round aluminum containers 1 1/4 × 2 inches; the film is interleaved with paper to protect it from scratches and may be filed away without further preparation. These shorter lengths are easier to handle. Films may be spliced together, however, and as many as 800 exposures stored in a can 4 1/8 × 1 3/4 inches, the standard can in which 100-foot lengths are sold. There is a disadvantage in storing the film in rolls, as it curls tightly and is sometimes difficult to handle when one attempts to look at one or more frames with a hand lens. Another method is to cut the film in shorter lengths and file flat in envelopes, or each film may be cut and mounted in a cardboard holder. These mounts are commercially available and inexpensive. With this method one or more frames may easily be viewed by hand lens, any desired data may be marked on the holder, the mounted films may be used as lantern slides without further preparation, and they are easily stored in shallow boxes or drawers two inches wide and the same height. One hundred mounts require about 5 linear inches or 20 cubic inches of space. The ordinary filing drawer for 3 × 5 inch cards holds 570 mounts.

For those interested in developing this apparatus for other uses, many types of reproductions may be made; the list is almost without end. By slotting the upright support, making the cross arm adjustable up and down, and calibrating it for film coverage, it is possible, by utilizing reflected light, to reproduce any type of record from small index cards to anything up to 14 × 21 inches in size. It will be necessary to mount two reflectors accommodating either regular or photoflood bulbs on opposite ends of the illuminating box to furnish the necessary light. Copies of rare or out-of-print books or reprints may be made for library use, and any of the above mentioned materials may be used for lantern slides. In addition pathological specimens, illustrations, and other data from textbooks or journals may be reproduced. In copying these it is to be kept in mind that the object camera distance must be measured from the surface of the object, and that for distances less than about 24 inches an auxiliary lens must be used with all cameras. A lens with a focal length of one meter (one diopter) will bring objects at a distance of approximately one foot into focus and will cover an area of about 6 × 9 inches at this distance. Many types of so-called reading machines and projectors are commercially available at reasonable prices.

SUMMARY

Excellent reproductions of radiographs are possible on 35-mm. film, the best type

of film for the purpose being Agfa Superpan reversible film.

A simple and inexpensive apparatus is described and illustrated, and its use is explained.

Methods of identification are discussed.

Disadvantages of the method are presented, and suggestions made for minimizing them.

Methods of storage are discussed.

Other uses of the apparatus are suggested.

The author wishes to express his gratitude to Mr. Karl Foesten, Mr. John Forrest, and the Research Staff of Agfa Ansco for their valuable help in preparing this paper.

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The Reproduction of Roentgenograms on Films of Millimetric Dimensions and Suggested Potentials of Utility in This Procedure

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THE INSPIRATION to an investigation of the reproduction of roentgenograms on films of millimetric dimensions was a quest for some method of lessening the demand for increased floor space and equipment to accommodate an ever enlarging volume of roentgenograms in which the findings were positive. An equally important need was centralization of a file which had become decentralized because of this expansion in volume. Both these were factors in increase of operating costs and in lessened efficiency of administration.

The reproduction of roentgenograms on films of millimetric dimensions was not new. It had been done for many years, but the results were never completely satisfactory. Some few individuals of outstanding ability and experience in photography had achieved what they considered excellent results. Experimental work with the assistance of some film manufacturers did not yield anything of practical value. A search was made for some commercial organization equipped to do this work in order to interest them in experimenting, with a view of adding a new line to the work which they were doing.

Eminently satisfactory reproductions were received from an incorporated group in a middle western city engaged in the making of motion pictures for advertising purposes. Arrangements were made to have them reproduce several thousand roentgenograms and lend their assistance in developing a microfilm reader particularly adapted to projection of the image of the miniature, in suitable magnification, on a translucent screen.

Reproduction of this large group has not been completed. The microfilm reader is still being studied with a view to improvement. But the work has progressed to the point where it seems prudent to present a preliminary report and mention some of the potentials that have become apparent as this work has progressed.

It was the consensus of the majority of a conferring group, which included roentgenologists, a trained technician, and a photographer of repute, that the reproductions exhibited a brilliancy of detail that equalled that of most of the original roentgenograms; in some cases, due to developments in lighting and electric eye control of exposure factors, the reproductions showed some improvement over the original.

A unit was devised containing a projector and the necessary reflectors to throw the image of the miniature film in magnification on an 18 × 16 inch (46 × 41 cm.) translucent screen set on the upper end of the front side of the unit. The buttons by which the projector unit can be manipulated are placed anteriorly and at a convenient level. The base of the unit is arranged for storage of the miniature films in rolls, providing space for at least 400 rolls. This means that a unit occupying at the most a floor space of 20 × 20 inches (51 × 51 cm.) will accommodate 320,000 individual miniature reproductions distributed in an orderly arrangement. This unit does not exceed 6 feet (1.8 meters) in height and, if desired, can be mounted on rubber-tired wheels. This allows it to be stored in any convenient space, wheeled out when wanted, and used in any desirable place where a light switch is available. The cost of this unit, considering all its advantages, could be made very reasonable.

For experimental purposes a group of

[1] Librarian, the Radiological Society of North America.

roentgenograms was chosen, all of which had been in file for at least ten years and had not been segregated into categories, as were the roentgenograms of later dates; all that were considered not to be of clinical significance or of sufficient educational value to warrant their reproduction were set aside. Sets of roentgenograms made in individual cases, in the group retained, were then studied and the superfluous films, with those which for any other reason did not warrant reproduction, were discarded. The films that had been thus set aside were sorted into various sizes, weighed, assembled into bundles convenient for handling, and sold. The revenue accruing from the sale of this discarded film reached a sum that gave promise of largely amortizing the cost of reproduction of the remaining roentgenograms.

The remaining roentgenograms were arranged in anatomicopathologic groups in accordance with the generally accepted indexes of the majority of libraries and general records of the majority of medical institutions. After being given legends to facilitate their identification in the miniatures, the roentgenograms were sent for reproduction in this order. The grouping was accomplished with the aid of facilities improvised largely from material which had been used in the packing of merchandise and had attained the status of waste, and the expenditure of time and effort required was less than had been anticipated. The educational advantages afforded more than repaid the time, effort, and thought involved on the part of the professional personnel. The greater part of the work was done by a single non-professional helper working under the supervision of one member of the professional personnel.

Because the roentgenograms in this group, as stated above, had never been segregated into categories, they probably were fairly representative of the files of the majority of hospitals, clinics, and analogous medical organizations on the North American continent.

Suggestions for Use of This Procedure: A prior arrangement of roentgenologic files had shown that a routine division of the roentgenograms into those on which the reports were positive and those on which the reports were negative allowed for a most convenient arrangement, whereby those with positive reports might be kept easily accessible for a much longer period than the others. A later arrangement divided the roentgenograms with positive reports into two categories: those with positive reports of clinical significance or subsequent educational value and those with positive reports of incidental findings which were of no clinical significance and of little or no subsequent educational value. The latter could be classified as essentially negative. Experience revealed that the roentgenograms on which reports were negative or essentially negative constituted a considerable proportion of the total file. From the standpoint of the roentgenologist these can be discarded within a very short period; they are retained in different institutions in accordance with settled policies of general administration. Except for a very small number that may have some educational interest, none of these is worthy of being considered for reproduction. When the agreed time for which they are to be retained has elapsed, they can be discarded and sold, the accruing revenue being used to help defray the cost of providing space and equipment for storage and any surplus credited to the fund for reproduction of the remaining roentgenograms. Under such an arrangement the space required for the roentgenograms in each category can be more or less stabilized, and discarding of those of one category and reproduction of those of the other can be arranged to conform with the space available. Personal experience would suggest that not over 35 per cent of all the roentgenograms made in any institution will prove worthy of being reproduced after they have been kept in file for five years. At the end of this period the great majority have lost their clinical significance and therefore need be retained only for the possible value they may have as educational material.

Economic Advantages Inherent in the Segregation of Roentgenograms: When roentgenograms are segregated in groups, as outlined above, those with negative findings can be shifted to less conveniently accessible storage spaces as necessity demands, with the minimum of inconvenience to the administration personnel. When these shifts are made at stated intervals, as for example every month or every year, each shifted group can be left in its own numerical or other sequence. This obviates filing of the shifted group in sequence with the roentgenograms of prior groups. The filing in of roentgenograms is time-consuming and when carefully checked proved to be a considerable item of expense in administration. When the time limit for the retention of the roentgenograms of the negative group has been reached, or should necessity demand it in the interim, these can be discarded *en masse* without necessity of supervision on the part of any member of the professional staff, with the minimal chance of loss of any material of educational value. The division of the file in definite sections also allows for its expansion or retraction to meet any circumstance with the minimum of expenditure of time, effort, and money.

Purposes of the Reproductions: The arrangement best suited to the reproduction of roentgenograms in miniature seems to be the making of a master film (the equivalent of the intermediate in the making of a lantern slide) and two copy rolls (facsimiles of the original roentgenogram). The master film can be retained by the department concerned with the making of prints for illustrations for publication, enlargements for other purposes, or composite lantern slides. One copy roll can be sent to the roentgenologic department, where it may be cut into individual films to be placed in envelopes or other containers on which the corresponding registration numbers or other identifying symbols are printed, typed, or written in such a manner that they can be quickly seen when the envelopes are placed in file. These miniature copies may replace the original roentgenograms in the file in the roentgenologic department. At the same time the number and symbol identifying the master film roll from which each was copied may be written on the envelope. If and when it is decided that the miniature can serve all the purposes of the original roentgenogram, then the reproduction may replace the original, which can be discarded. The revenue from the sale of these discarded films will still further augment the fund available for the reproduction of the original roentgenograms. The second copy roll is sent to the library of the institution concerned, where it may be retained as a roll and used with the aid of the microfilm reader for purposes of study.

Study of a group of films concerning a definite subject is best done in the library. If inspection or study of a single miniature or a small group of miniatures is desired, and the registration number or other identifying symbol is known, the required film may best be obtained from the roentgenologic department.

Economies in Administration: While the diminution of the volume of the file, which would obviate the necessity for capital expenditures to provide additional floor space and equipment for a constantly growing number of roentgenograms, and centralization of the file to eliminate the expenditure of time and effort inherent in decentralization, were the original purposes of the investigation, other potentials of economy became apparent as the study progressed.

Before being sent for reproduction, all roentgenograms had the registration number or other identifying symbol cut by a stenciling machine in the left vertical margin. The date on which the roentgenogram was made was similarly cut into the right vertical margin of the film. When the roentgenograms were assembled ready to be sent for reproduction, those constituting each roll were numbered consecutively from 001 to 800, the appropriate numerals being cut in the upper horizontal margin of the film. With the reproductions grouped in accordance with other

indexes on 100 foot (30 meter) rolls, 800 individual miniatures on each roll, anyone desiring to study any specific group of roentgenograms could be sent to the library to examine these instead of withdrawing them from the file and returning them when the study was completed. With the prior elimination of all superfluous roentgenograms by a trained roentgenologist and the reproduction of only those of importance, much time and effort can be conserved in subsequent studies. If and when this procedure is developed to the point where all the material to a given date is included in the library collection, it will afford a convenient and rapid survey of all the available roentgenographic illustrations on any given subject. A preliminary study of these might easily save time and effort in compiling lists and even eliminate the withdrawing of the general records of patients from file for certain purposes. The study of the roentgenographic images can be carried out under much more comfortable and convenient circumstances in the library and, when desired, a concurrent study of the literature is possible.

If, in the course of such a study, it were desirable to use any individual miniature —or group of miniatures—as a lantern slide, the registration number or similar identifying symbol could be noted and on request the copy in file in the roentgenologic department could be placed in a temporary mount and made available in a few moments. When the purpose was served the copy could be removed from the temporary mount and returned to file. It would not be necessary to have lantern slides made up from roentgenograms for many purposes. The library rolls would contain a more comprehensive collection of roentgenographic images of any given condition and could in time be brought to include all available material on the subject. If and when this is accomplished, the necessity of making lantern slides to keep track of interesting cases will be completely eliminated. When prints for publication or reproductions or enlargements of the miniature are required for any purpose, a note of the number and code symbol denoting the roll being studied, as for example C 5, K 4, etc., and the sequence number of the film wanted on the roll, are all that will be required to enable this to be quickly located in the photographic department. Small cards could be devised, printed, and made conveniently available from the microfilm reader on which to note the data of the copy required for any purpose. If these were made of a size to fit the envelope in the file of the roentgenologic department, one card could be used for each lantern slide copy to be mounted. These cards could then be placed in the envelopes in lieu of the miniature copy and remain there as a charge until the copy was returned to file.

Insurance against Loss of Valuable Scientific Material: In most institutions the original roentgenograms are the only existing graphic records of outstandingly interesting examples of the normal and its variations and of various types of abnormalities as exemplified in the roentgenographic image. Most roentgenologic files contain much that is invaluable for the teaching of anatomy and pathology. A little of this great mass of material in the average institution may have been reproduced in lantern slides or otherwise segregated. The remainder is most frequently kept in a single file. This whole collection could be wiped out by fire or other unavoidable occurrence. Fire regulations, and insurance rates based on compliance with these, require expensive installations for files convenient to roentgenologic departments to facilitate administration. The reproduction of the roentgenograms provides at once two, three, or more copies, as desired, which can be distributed widely in any institution. This at once minimizes the chance of any total loss of this valuable material. The master film could well be kept in a fireproof safe or vault to insure further against its loss.

Influence of the Miniature Roentgenogram on Teaching: Reproductions of roentgenograms on films of millimetric dimensions compiled as outlined above afford an

opportunity for education in roentgenology impossible prior to its accomplishment. The study of all available examples of the roentgenographic image in any given abnormality in a form that will allow a convenient concurrent study of the literature under the most comfortable circumstances should stimulate a desire for more complete knowledge of a given subject and its correlated roentgenologic features. Stereoscopic sets can be reproduced in miniature and studied by means of a simple stereoscope in the form of a pair of opera glasses or projected in magnification on a metal screen and studied in third dimension with the aid of spectacles fitted with lenses of polaroid material.

It has been the desire of some of the officers, past and present, of the Radiological Society of North America to establish a roentgen film library that could be made available to those with lesser opportunities for study. Prior attempts failed because of the lack of any space available to contain a library in the form then considered. In 1938 the suggestion was made that, if and when reproduction of roentgenograms on films of millimetric dimensions was accomplished, it might be possible to establish a National Roentgenologic Library as a part of the Army Medical Library in Washington. My experience with the procedure to the present encourages me in the belief that not only is the accomplishment of this aim now feasible, but that it can be achieved well within the means of the local, state, and national societies which would participate in the undertaking.

The simplest procedure for the development of such a library would be for the local societies in the larger centers to induce their members to pool their roentgenograms of outstanding interest or educational value and send them, after they had been edited, furnished with legends, and arranged, to be reproduced. The master film roll could be left in the custody of the producing organization or otherwise handled as circumstances dictated. One copy roll could be donated to the library of the local medical society or academy of medicine, the local roentgenological society donating the microfilm unit with the aid of which these films could be studied. The other copy roll could be donated to the national society sponsoring the establishment of the National Library. In the more sparsely settled areas, a similar procedure could be carried out by the state roentgenological society, one copy roll and a microfilm unit being donated to the library of the state university. The state society would also donate one copy roll to the national society.

The National Roentgenologic Library would be established by the national society sponsoring the project, and this society would donate the microfilm unit to the Army Medical Library. Donations of copy rolls would be made through the national society, the officers of which, in consultation with the librarian of the Army Medical Library, would adopt the necessary regulations to maintain this section of the library. It would seem perfectly feasible to allow any local or state roentgenological society to purchase copies of the rolls of reproductions of any other local or state society to donate to its own local medical library or state university library, as its means permitted. Obviously, because all film studies would be donated, it would not seem wise to allow individuals to purchase any of the copy rolls for personal use. To allow the miniatures of any copy roll to be used for teaching purposes, all copy rolls made for donations to the national library, or copies of the rolls in the national library made for donation to other libraries, could have a "water mark" of lettering or other identification symbol incorporated into the background of the film in such a manner that it would not interfere in any way with the delineation of the roentgenographic image, but yet could not be masked without destroying the integrity of the image. As a further precaution against the use of the roentgenographic reproductions for any purpose other than that for which they were devised, the national society could, if necessary, copyright the contents of each roll. It would

then be in a position to prosecute anyone infringing the rules implied by the copyright.

The establishment of a National Roentgenologic Film Library and branch reference libraries as outlined would widen the scope of roentgenologic teaching by providing teaching material for institutions of lesser opportunity. Even in the larger institutions it would assemble large groups of instructive illustrations in a compact form, easily accessible for study under most favorable conditions. Copy rolls and less elaborate forms of microfilm readers could be provided for the pathologic laboratories. A more thorough appreciation of the value of the roentgenogram in the teaching of pathology would be engendered. The closer relation of the pathologist and the roentgenologist in the study of morbid anatomy would be mutually helpful.

A keener appreciation of the value of roentgenology in the making of a diagnosis would be established by the installation of these libraries of miniatures as widely as possible in a form that would make them easily accessible for study or for reference.

The possibility of obtaining roentgenograms, or copies in miniature, depicting lesions seldom or never seen on our own continent and having copy rolls made of these for the national library and for distribution to the libraries in cities and state universities could be considered. Many local and state societies would be interested in any co-operative effort made to secure these.

A future function of the national society might easily be an arrangement to re-establish the roentgenologic libraries of foreign countries as a national gesture of good will, when the present world-wide conflict ends. Many of these will probably be lost in the general destruction incident to the warfare of today.

This preliminary report is made to encourage others, many of whom have long been concerned with similar problems, to experiment and study. Out of such studies there may well come a co-operative effort in the solution of these problems and later suggestions which will be of mutual benefit.

Mayo Clinic, Rochester, Minn.

Protective Screening of Radium During Transportation[1]

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Washington, D. C.

THE USE OF RADIUM by the medical profession involves the important problem of rapid transportation over considerable distances by commercial carriers such as the Post Office and express companies. For many years, in the United States, such shipments were made freely, chiefly by mail. Though in many instances little screening by lead or other dense metal was provided, during a period of approximately twenty-five years no instance of injury or damage was reported. So far as personal injury is concerned, this is not surprising, since the average time of exposure of any employee to a radium package is short and the distances are likely to be such as to afford adequate protection. In 1937, however, at least one instance in which a shipment of photographic film was damaged by being placed near a shipment of radium came to the attention of the Post Office Department. After a short investigation all radioactive materials were excluded from the mails on the basis of a regulation of long standing, which prohibits the mailing of any potentially dangerous materials.

This action led to considerable protest from shippers and users of radium for medical purposes, and, as a result, the Post Office Department requested the National Bureau of Standards to investigate conditions under which radium might be transported without damage to photographic film in transit at the same time.

Preliminary exposures of ultra-speed x-ray film to preparations of various radium content through different lead filters at distances ranging from a few inches to several feet clearly revealed that for radium preparations containing from 25 to 100 mg. of radium no reasonable amount of lead screening alone would protect photographic films for the length of time they might be expected to be together in a mail pouch or even nearby in the same mail car. It became evident, therefore, that here, as in many other cases in which absolutely safe protection from radium radiation is required, the inverse square law must be utilized, by restricting the minimum distance between the radium package and the shipment of photographic film. Further exposures revealed that this minimum distance would vary between 4 feet and 20 feet, depending upon the length of exposure, thickness of the lead filter, and the strength of the radium preparation.

The results of these preliminary tests showed conclusively that no convenient package could be designed which would permit safe contact with photographic films during such periods as they might be in transit. It was necessary, therefore, that arrangements be made to segregate radium shipments from those containing photographic film. The intervening distance must, in some cases, be as great as 20 feet.

Up to the present time the Post Office Department has not been able to find any way to provide the necessary segregation of radium shipments. The low cost of parcel post shipments has been achieved by packing shipments close together to make the most of the available space in mail cars. Consequently, the ban on the shipment of radium in the mails is still in force.

The express companies are not quite as restricted as regards space in their cars and have been able to continue the shipments of radium in instances in which they know the conditions for each package handled to be safe. In order to be certain of proper treatment, it is therefore necessary that (1) each package containing radium be clearly so marked; (2) that the amount of

[1] Presented before the Fifth International Congress of Radiology, Chicago, Sept. 13–17, 1937.

radium contained should appear on the outside; (3) that the thickness of lead screening be indicated. With this information it is possible for employees to maintain a proper distance from film shipments. Possible damage to films may thus be prevented.

The National Bureau of Standards has made several series of test exposures to obtain data for preparing tables of safe distances under the various conditions likely to be met with in practice. At the outset it seemed reasonable to request all shippers of radium to limit individual shipments to 100 mg. and therefore the number of test exposures to cover conditions likely to arise during transportation could be limited. It was decided to make exposures for 25 mg., 50 mg., and 100 mg., with lead screening for each amount of radium of 0.5 cm., 2 cm., and 4 cm. From these data it would be possible to interpolate to obtain figures for any actual shipment. Exposures were also made for 10 hours, 20 hours, and 40 hours. In each of these tests a number of films were exposed over a considerable range of distances to insure that some would show fogging and others would not. From a careful examination of the films, the safe distance for each test condition was determined. In all cases Eastman ultra-speed x-ray film was used, with a narrow strip of 0.5 cm. lead across the face and about an equal thickness of wood between the lead strip and the film. This arrangement yielded a definite unfogged area whenever there was sufficient radiation to cause any appreciable fogging on remaining portions of the film. Observations were made by placing the film on a white sheet of paper and viewing it by reflected light. Fresh developer of the same formula at the same temperature was used in all cases, and development was carried out for the same length of time (eight minutes).

TABLE I.—SHOWING CONDITIONS UNDER WHICH RADIUM MAY BE SHIPPED.

QUANTITY OF RADIUM	THICKNESS OF LEAD - INCHES								
Milligrams	1/4	1/2	1	1 1/2	2	2 1/2	3	3 1/2	4
	Allowable hours in transit								
Under 15 mg	40	60	110						
15 mg & under 25	20	30	55	110					
25 mg & under 35	14	20	36	73	146				
35 mg & under 45	10	15	28	55	110				
45 mg & under 55		12	22	44	88	170			
55 mg & under 65		10	18	36	73	142			
65 mg & under 75			16	31	63	122			
75 mg & under 85			14	27	55	106			
85 mg & under 95			12	24	48	95			
95 mg & under 100 incl.			11	22	44	85	170		
200 mg				11	22	43	86	172	
300 mg					14	28	56	112	
400 mg					11	22	44	88	172
500 mg					8	17	34	68	136
600 mg						14	28	56	112
Minimum weights of lead, pounds	1/2	3/4	3 1/4	9 1/4	9 1/2	36	58 1/2	91	135

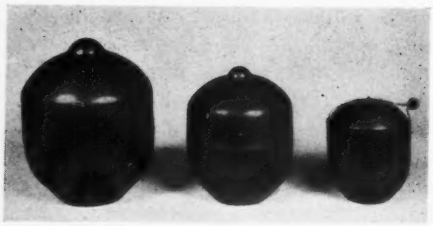

Fig. 1. Concentric lead shields for shipment of radium. Exterior view.

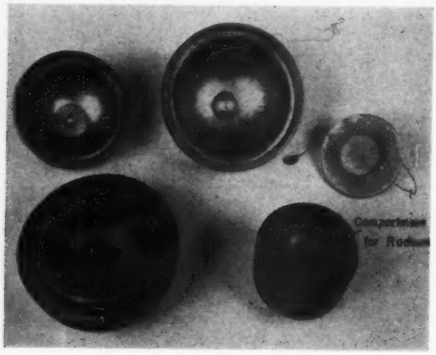

Fig. 2. Interiors of lead shields for shipment of radium.

The results of these tests are shown in Table I. These figures have been adopted by the express companies to determine conditions under which radium may be shipped. It is now necessary to affix to a package containing radium a label which states the amount of radium and the thickness of lead which surrounds it. The thicknesses of lead required in accordance with Table I are considerably greater than were customarily used before this investigation was made. However, they do not demand excessive amounts of lead. In many cases 25 pounds or less will meet the requirements. Where the distance between shipping points is considerable and the amount of radium is in excess of 100 milligrams, between 50 and 100 pounds of lead are required.

The protective measures discussed above

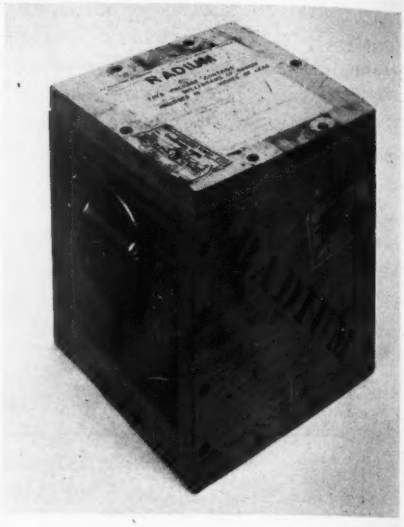

Fig. 3. Wood box containing radium in lead shield prepared for shipment.

apply only to safeguarding photographic film from injury. A by-product of these results is a considerable security to individuals who handle radium in the course of its transportation. When radium is prepared for shipment in accordance with the requirements of Table I, there is very little possibility of injury to persons handling the package during shipment.

A convenient method which provides requisite thickness of lead is shown in Figures 1 and 2. The lead shields consist of concentric shells which may be placed around the innermost container. In the illustration the inner container has lead walls $1^1/_2$ in. thick and each shell has a wall thickness of $^1/_2$ in. Thus the complete assembly provides a container with walls 2 in. thick. This arrangement provides considerable flexibility in adjusting the lead container to fit the requirements of a particular shipment. The lead container is packed in a wood box, as shown in Figure 3.

National Bureau of Standards,
Washington, D. C.

EDITORIAL

Howard P. Doub, M.D., Editor

John D. Camp, M.D., Associate Editor

Radiation Therapy in Chronic Arthritis

The story of the attempt at specific therapy of chronic arthritis has been one of alternating hope and disappointment. Each new method has been attended by high hopes of cure, but nearly all have met with indifferent success. Symptomatic and generalized therapy have usually retained the most adherents. It is natural, therefore, that radiation therapy should have been tried for the relief of this baffling disease.

One of the first reports on roentgen irradiation for arthritis, in the American literature, was by Anders, Daland, and Pfahler,[1] who reported considerable improvement in the two chronic cases which they treated. They believed that the rays stimulated and increased metabolism within the joint. Langer,[2] proceeding on the theory that arthritis is related to disturbances of the vegetative nervous system, centered the radiation over the paravertebral areas and over the two sides of the neck. He also applied local treatment over the joints. His results convinced him that radiation is superior to other therapeutic agents.

In 1940 Hare[3] reported a series of 35 cases of Marie-Strümpell arthritis of the spine, in which he had employed roentgen therapy. He believes pain can be relieved in 80 per cent of these patients and that usually only small doses are required to obtain this result. Relief of pain may be observed during the first two or three weeks. At the time of his report 33 of his 35 patients were able to work, including 5 who were formerly incapacitated. He applied the radiation over the spine, sacroiliac joints, and paravertebral and gluteal muscles.

In a recent report on the efficacy of roentgen therapy in rheumatic disease, Smyth, Freyberg, and Peck[4] detailed the results of their observations on a selected group of these patients. This group had been carefully studied in the Rackham Arthritis Unit of the University of Michigan. In nearly every case there was comparable involvement in a pair of joints. It was possible, therefore, to treat one of the joints with roentgen irradiation and leave the corresponding joint untreated to serve as a control for a better evaluation of the therapeutic result. The only other therapy was of a general nature: rest, salicylates, antianemic therapy, heat, and exercise.

The roentgen technic consisted of the following factors: 200 kv.; 0.5 mm. copper and 1.0 mm. aluminum filtration; 50 cm. skin target distance; 50 r per minute (measured in air); usual size of field approximately 15 × 15 cm. Each field was treated three times, receiving 200 r at each sitting. The treatments were given every other day. Most patients received three series to the same part with an interval of four to six weeks between series. In order to study the psychic effect that might be associated with the irradiation a lead screen was sometimes inserted to protect the part

[1] Anders, J. M., Daland, J., and Pfahler, G. F.: The Treatment of Arthritis Deformans with the Roentgen Rays. J. A. M. A. **46:** 1512, 1906.

[2] Langer, Heinz: Roentgen Therapy in Arthritis. Radiology **20:** 78, 1933.

[3] Hare, Hugh F.: The Diagnosis of Marie-Strümpell Arthritis with Certain Aspects of Treatment. New England J. Med. **223:** 702, 1940.

[4] Smyth, C. J., Freyberg, R. H., and Peck, W. S.: Roentgen Therapy for Rheumatic Disease. J. A. M. A. **116:** 1995, May 3, 1941.

from the rays. This was done without the patient's knowledge and in various time combinations with the usual roentgen therapy.

The clinical results obtained in the various types of rheumatoid disease are charted as to subjective and objective benefits. In rheumatic arthritis it was found that 44 per cent of the patients received no benefit whatever from roentgen therapy, and that in 74 per cent there was no objective evidence of improvement. Objective evidence of benefit was present in 26 per cent but was of significant grade in only 14 per cent. In 21 per cent of the series the subjective improvement, which was the only benefit noted in this group, lasted less than one month. Roentgen therapy did not appear to confer any protection against subsequent acute exacerbations of the disease, as they occurred as frequently in the treated joints as in the untreated ones.

Roentgenographic study was made of the joints during and following roentgen therapy. In no case was any anatomic improvement demonstrated. There was no correlation between changes in the roentgenograms and the clinical results. In some instances roentgenographic evidence of further anatomic change was apparent even in the presence of symptomatic improvement.

In a later report from the same institution, Smyth, Freyberg, and Lampe[5] discuss the results obtained with roentgen therapy in 52 cases of spondylitis rhizomélique. The same roentgen technic was employed in this series as in the previous series except that the total dose was somewhat lowered. In this report the authors analyze the influence of roentgen therapy on pain, stiffness, motion of the spine and hips, chest expansion, and body weight. In 72 per cent of the patients there was a significant degree of subjective benefit, and in 50 per cent there was significant benefit as shown by objective clinical changes.

In breaking down these results according to the stage of the disease as depicted roentgenographically the writers state that 12 of the 13 patients with early arthritic changes were significantly improved, both subjectively and objectively. Of 19 patients with moderately advanced disease, 13 reported definite symptomatic improvement, while 7 showed similar objective clinical improvement. Twenty of the patients had far-advanced disease. Fifteen of these showed definite symptomatic improvement and 7 manifested physical signs of improvement. The results indicate that here, as in most other diseases, the therapeutic results vary indirectly in proportion to the stage and extent of the pathological process.

Smyth and his associates were unable to find any satisfactory explanation of the modus operandi of roentgen therapy in this group of diseases. Anders, Daland, and Pfahler, as mentioned above, attributed the effect of irradiation to stimulation of the metabolism in the joint, while Langer believed that chronic arthritis is related to disturbances of the vegetative nervous system and that irradiation of the vegetative nerve centers exerts a stimulative action followed by a sedative effect. Others have advanced theories based on immunologic processes and vascular changes. It is well known that following roentgen therapy there occurs a marked hyperemia of the part, which persists for a much longer time than that following the external application of heat. Some feel that this may represent the beneficial agent.

In most of the reported series relief of pain has been the outstanding benefit. The course of the joint changes and ligamentous calcification has usually not been materially altered. In cases of active rheumatoid disease the erythrocyte sedimentation rate is usually elevated. Smyth and his co-workers found that among their cases with reduction in the sedimentation rate a high percentage showed clinical improvement, in many instances of a corresponding degree.

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[5] SMYTH, C. J., FREYBERG, R. H., AND LAMPE, I.: Roentgen Therapy for Rheumatoid Arthritis of the Spine. J. A. M. A. **117:** 826, Sept. 6, 1941.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

TWENTY-SEVENTH ANNUAL MEETING, SAN FRANCISCO
DEC. 1–DEC. 5, 1941

SCIENTIFIC PROGRAM

Monday, December 1

GENERAL ASSEMBLY

10:15–10:45 A.M.

Call to Order, by the President

Address of Welcome

SYMPOSIUM ON BRAIN TUMORS, 10:45 A.M.

John D. Camp, M.D., Chairman

1. Pathology of Brain Tumors and Its Relation to Roentgenologic Diagnosis, EDWIN B. BOLDREY, M.D., San Francisco, Calif.
2. Reliability of Brain Tumor Localization by Roentgen Methods, F. J. HODGES, M.D., and V. C. JOHNSON, M.D., Ann Arbor, Mich.
3. Intracranial Calcifications of Non-neoplastic Origin, JOHN D. CAMP, M.D., Rochester, Minn.
4. Application of Some New Technics in the Study of Brain Tumors, E. R. WITWER, M.D., Detroit, Mich.

DIAGNOSTIC SESSION, 2–5 P.M.

Mucosography of the Organs of the Respiratory Tract, PEDRO L. FARINAS, M.D., Habana, Cuba

Lung Tumors, FRANK S. DOLLEY, M.D., Los Angeles, Calif.

SYMPOSIUM ON FUNGOUS INFECTIONS

Leo Henry Garland, M.D., Chairman

1. Parallelism of Coccidioides and Tuberculosis Infections, CHARLES E. SMITH, M.D., San Francisco, Calif.
2. Acute Pulmonary Coccidioidomycosis—Roentgen Studies in an Epidemic, ROBERT A. POWERS, M.D., Palo Alto, Calif.
3. Roentgen Diagnosis of Fungous Infections of the Lungs, with Special Reference to Coccidioides, RAY CARTER, M.D., Los Angeles, Calif.
4. Roentgen Diagnosis of Fungous Infections of the Intestinal Tract, ALBERT K. MERCHANT, M.D., Stockton, Calif.
5. Roentgen Diagnosis of Coccidioidal Infections of Bone, CARL BENNINGHOVEN, M.D., San Mateo, Calif., and EARL MILLER, M.D., San Francisco, Calif.

THERAPEUTIC SESSION, 2–5 P.M.

SYMPOSIUM ON CANCER OF THE BREAST

William E. Costolow, M.D., Chairman

1. General Management of Patients Undergoing Treatment for Malignancy, LOWELL GOIN, M.D., Los Angeles, Calif.
2. Roentgen Therapy in Cancer of the Breast: An Analysis of our Experience at the State of Wisconsin General Hospital During the Last 12 Years, ERNST A. POHLE, M.D., Madison, Wis.
3. Place of Irradiation in Cancer of the Breast, FREDERICK O'BRIEN, M.D., Boston, Mass.
4. Pathology of Breast Tumors, JOHN W. BUDD, M.D., Los Angeles, Calif.
5. Preoperative Irradiation of Breast Tumors, ALBERT SOILAND, M.D., Los Angeles, Calif.
6. Surgical Aspect of Carcinoma of the Breast, ALSON KILGORE, M.D., San Francisco, Calif.
7. Radiation Osteitis of the Ribs, LESTER W. PAUL, M.D., Madison, Wis.

Tuesday, December 2

SYMPOSIUM ON INFLAMMATIONS

A PANEL DISCUSSION

10:30 A.M.

Eugene P. Pendergrass, M.D., Chairman

1. Mechanism of the Result of Roentgen Therapy, ARTHUR DESJARDINS, M.D., Rochester, Minn.
2. Value of Roentgen Therapy in the Treatment of Pneumonia Which Fails to Respond to Sulfonamide Therapy, J. P. ROUSSEAU, M.D., Winston-Salem, N. C.
3. Roentgen Therapy of Sinus Disease, W. C. POPP, M.D., Rochester, Minn.
4. Further Observations on the Radium Treatment of Acute Postoperative Parotitis, ROBERT FRICKE, M.D., and GORDON F. MADDING, M.D., Rochester, Minn.
5. Roentgen Therapy of Peritonitis, JAMES F. KELLY, M.D., Omaha, Neb.
6. Roentgen Therapy of Postoperative Parotitis, EUGENE P. PENDERGRASS, M.D., and PHILIP J. HODES, M.D., Philadelphia, Penna.

DIAGNOSTIC SESSION, 2:45–5:00 P.M.

SYMPOSIUM ON THE GASTRO-INTESTINAL TRACT

1. Dosage of X-radiation Incident to Fluoroscopic Examination, A. L. L. BELL, M.D., Brooklyn, N. Y.
2. The Stomach and Small Intestines in the Infant, JOHN S. BOUSLOG, M D., Denver, Colo.
3. The Colon in the Healthy New-Born Infant, SAMUEL G. HENDERSON, M.D., and W. W. BRYANT, JR., M.D., Pittsburgh, Penna.
4. Gastro-Intestinal Tract of the Child, WM. C. DEAMER, M.D., and CHARLES CAPP, M.D., San Francisco, Calif.

The Clinico-Anatomical Aspect of the Lumbo-Sacral Region, JOHN B. DEC. N. SAUNDERS, M.D., and VERNE T. INMAN, M.D., San Francisco, Calif.

Thorotrast and the Diagnosis of Lesions Involving the Lower Spinal Canal, BERNARD H. NICHOLS, M.D., Cleveland, Ohio

THERAPEUTIC SESSION, 2:45–5:00 P.M.

ROUND TABLE DISCUSSION ON THE LEUKEMIAS AND LYMPHOBLASTOMAS

John Lawrence, M.D., and R. R. Newell, M.D., Presiding

H. P. Hill, M.D., San Francisco, Calif.
Ernest Falconer, M.D., San Francisco, Calif.
David A. Wood, M.D., San Francisco, Calif.
Harry Wyckoff, M.D., San Francisco, Calif.

CARMAN LECTURE, 8:00 P.M.

Fluoroscopes and Fluoroscopy, W. EDWARD CHAMBERLAIN, M.D., Philadelphia, Penna.

Wednesday, December 3

CYCLOTRON SYMPOSIUM, 10:30 A.M.–1:00 P.M.

Robert S. Stone, M.D., Chairman

1. The Cyclotron and Nuclear Physics, PAUL C. AEBERSOLD, PH.D., Berkeley, Calif.
2. Artificial Radioactive Elements in Metabolic Studies, JOSEPH G. HAMILTON, M.D., Berkeley, Calif.
3. Artificial Radioactive Elements in the Treatment of Disease, JOHN H. LAWRENCE, M.D., Berkeley, Calif.
4. Neutrons in the Treatment of Disease, JOHN C. LARKIN, M.D., Berkeley, Calif., and ROBERT S. STONE, M.D., San Francisco, Calif.
5. Further Experiences in the Treatment of Lymphosarcoma with Radioactive Phosphorus, JOHN M. KENNEY, M.D., New York, N. Y.

DIAGNOSTIC SESSION, 2–5 P.M.

SYMPOSIUM ON THE LESSER CIRCULATION

1. Emphysema in Cases of Angina Pectoris, WM. KERR, M.D., San Francisco, Calif.
2. Studies of the Pulmonary Circulation by Means of Body Sectional Radiography, WENDELL SCOTT, M.D., St. Louis, Mo.
3. Diseases of the Lesser Circulation, FRED ANGLE, M.D., Kansas City, Kans.

VITAMIN DEFICIENCIES AND ENDOCRINE DISEASES

1. The Value of Roentgen Ray in the Diagnosis of Endocrine Diseases, PAUL J. CONNOR, M.D., Denver, Col.
2. Treatment of Endocrine Disorders by Small Doses of X-ray, JAMES H. HUTTON, M.D., Chicago, Ill.
3. Clinical Diagnosis of Beri-Beri Heart Disease, ARTHUR C. MCKENNEY, San Francisco, Calif.
4. Roentgen Diagnosis of Vitamin-Deficiency Cardiac Conditions, L. HENRY GARLAND, M.D., San Francisco, Calif.

Incidence of Multiple Primary Tumors and the Problems of Acquired Cancer Immunity, ERNST A. SCHMIDT, M.D., Denver, Colo.

Technic and Results in Dental X-ray, GORDON FITZGERALD, D.D.S., San Francisco, Calif.

THERAPEUTIC SESSION, 2 P.M.

VISIT TO THE CYCLOTRON

Conducted by John H. Lawrence, M.D.

Thursday, December 4

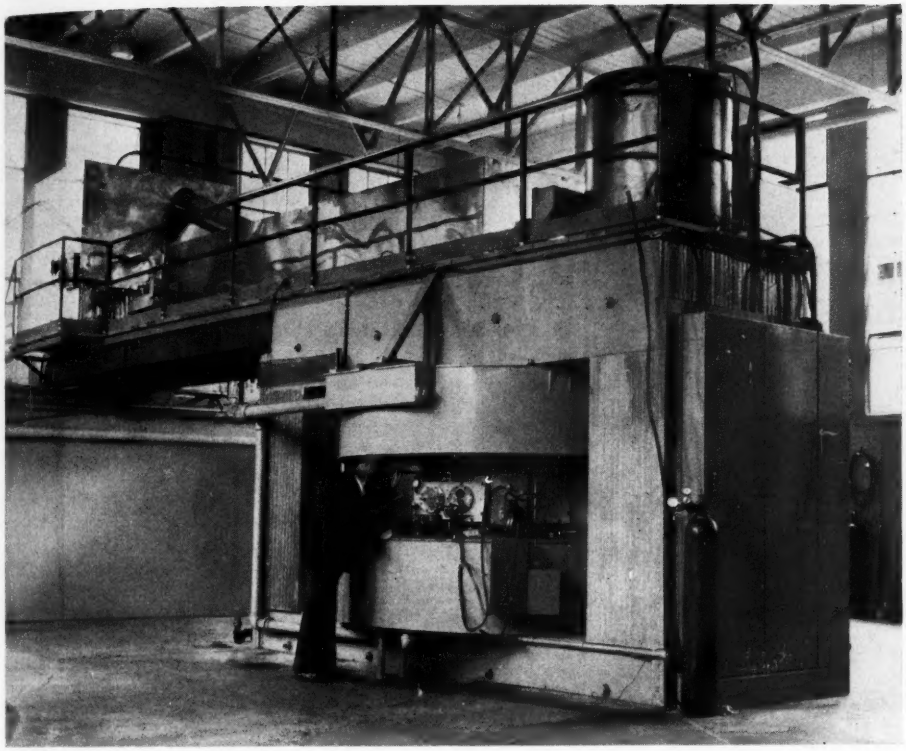
SYMPOSIUM ON DISEASES OF THE RETROPERITONEUM—A PANEL DISCUSSION, 10:30 A.M.

Lewis G. Allen, M.D., Chairman

1. F. C. HELWIG, M.D., Kansas City, Kansas
2. REX L. DIVELY, M.D., Kansas City, Kansas
3. T. LEON HOWARD, M.D., Denver, Colo.
4. BENJAMIN H. ORNDOFF, M.D., Chicago, Ill.
5. DABNEY KERR, M.D., Iowa City, Iowa
6. T. D. CUNNINGHAM, M.D., Denver, Colo.

DIAGNOSTIC SESSION, 2:45–5:00 P.M.

1. The Specialist as a Medical Naval Officer, CAPTAIN A. H. DEARING, U. S. Navy, Mare Island, Calif.
2. Micro-Film in Roentgenological Education, CHARLES G. SUTHERLAND, M.D., Rochester, Minn.
3. Fluorographic Examination of the Chest as a Routine Hospital Procedure, FRED J. HODGES, M.D., Ann Arbor, Mich.
4. Endothelioma of the Pleura. Clinical and Roentgenologic Studies of Three Cases, HOWARD P. DOUB, M.D., and HORACE C. JONES, M.D., Detroit, Mich.
5. Carcinoma of the Lung in Infancy, HARRY HAUSER, M.D., Cleveland, Ohio



The Cyclotron in the Radiation Laboratory of the University of California on the Berkeley campus. This 220-ton instrument is being devoted chiefly to the therapy of neoplastic disease.

6. Bone Lesions in Hodgkin's Disease and Lymphosarcoma, H. L. FRIEDELL, M.D., South Bend, Ind.

THERAPEUTIC SESSION, 2:45–5:00 P.M.

1. Influence of the Medium on the Radiosensitivity of Sperm, G. FAILLA, Sc.D., New York, N. Y., with collaborators
2. X-rays in the Management of Non-Malignant Diseases in the Organs of the Female Pelvis, BENJAMIN ORNDOFF, M.D., Chicago, Ill.
3. Treatment of Hemangiomata with Special Reference to Unsatisfactory Methods, WILBUR BAILEY, M.D., Los Angeles, Calif.
4. Observations on Radiodermatitis, ERICH UHLMANN, M.D., Chicago, Ill.
5. Present Status of Roentgen Therapy in Chronic Paranasal Sinusitis, FRANK E. BUTLER, M.D., and IVAN M. WOOLLEY, M.D., Portland, Ore.
6. Preliminary Report of the Effect of Combined Fever and Deep X-ray Therapy in the Treatment of Far Advanced Malignant Cases, H. S. SHOULDERS, M. D., Nashville, Tenn., and collaborators
7. X-ray Treatment of Hyperthyroidism, ROBERT S. STONE, M.D., AND MAYO H. SOLEY, M.D., San Francisco, Calif.

Friday, December 5

SYMPOSIUM ON DISEASES OF THE BONES
PANEL DISCUSSION, 10:15–12:15 A.M.

David S. Beilin, Chairman

1. Classification of Bone Tumors, KENNETH S. DAVIS, M.D., Los Angeles, Calif.
2. Clinical Pathology of Bone Tumors and Treatment, J. VERNON LUCK, M.D., Los Angeles, Calif.
3. Development of Bone in Relation to Formation of Neoplasms, KEENE O. HALDEMAN, M.D., San Francisco, Calif.

12:15–1:00 P.M.

1. Practical Considerations Regarding the Employment of Various Qualities of Roentgen Rays in Therapy, EDITH QUIMBY, Sc.D., New York, N. Y.
2. Radiation in Corpus Uteri Cancer, IRA I KAPLAN, M.D., New York, N. Y.

Announcements

RADIOLOGICAL SOCIETY OF NORTH AMERICA: ANNUAL MEETING

TRANSPORTATION TO SAN FRANCISCO

The "San Francisco Limited," leaving Chicago Wednesday, Nov. 26, 10:25 P.M., over the Chicago and Northwestern Railway, reaching San Francisco Saturday, Nov. 29, 8:25 A.M., has been listed as "The Radiological Special."

Reservations on this (or any other train) must be made personally, through your own local ticket agent, as the Transportation Committee cannot be responsible for any reservations.

Other routes and other trains, as well as air and bus transportation, are available, and each must decide for himself the route he will take. If you wish to save time it is suggested that you look up the air line or the streamliner railroad schedules. Remember that if you wish to travel on the streamliners, or by plane, the space is limited and reservations must be made well in advance to secure accommodations.

The railroad fare quoted by the Chicago and Northwestern Railway (as of September 15) is $90.30 round trip, Chicago to San Francisco and return (one way only, $66.53). Therefore you save about forty dollars by buying a round trip ticket. This does not include Pullman charges, which will depend upon the accommodations selected, but which may be estimated on the basis of the cost of a lower berth, which is $16.55, Chicago to San Francisco, one way. (Meals not included.)

Tickets may be routed to return *via* the same or any other direct line, including the southern or northern routes, but in order to secure the round trip rate the return trip must be routed at the time of buying the ticket, from the starting point.

The "Radiological Special" carries a buffet club car, club lounge car, Pullman cars with drawing rooms, compartments, bedrooms and sections, and a through dining car.

It will be possible to join the train at Omaha, Nebraska, at 10:00 A.M., Thursday, Nov. 27, or at Ogden, Utah, at 8:05 A.M., Friday, Nov. 28, providing reservations are made in advance through your local agent.

The "Radiological Special" will not make any sight-seeing stops.

Answers to the questionnaire in the September RADIOLOGY were so few that your committee did not feel justified in attempting any sight-seeing schedule. Letters received indicated that almost everyone who wanted any sight-seeing wished to omit something that someone else desired to include. A ten-day pre-convention tour, taking in the Southern route, covering the Indian country, Albuquerque, New Mexico, Santa Fe, Grand Canyon, Boulder Dam, Los Angeles, Catalina Island, Hollywood, etc., has been lined up by the American Express Company, but not enough have shown advance interest in this trip to make it an official Radiological Special Tour. It is believed, however, that as the members think the matter over there may be those who will wish to make such a trip. If you wish information on this trip, or on other sight-seeing trips which may be less extensive, you should write at once to Mr. W. L. McAvey, Mgr. Convention Division, American Express Co., 65 Broadway, New York, N. Y. You of course may arrange your own sight-seeing schedule for either the trip out or the trip back, and you will find your own local passenger ticket agent ready to assist you, whatever route you may decide to take.

For many of us this will be an opportunity which may not come again in a long time and the chance to spend a few days in sight-seeing should not be missed.

To mention a few of the many places of interest—in addition to those noted above—there are Denver, Salt Lake City, Reno, Sun Valley, and Cheyenne.

Incidentally, of interest to any who may be going to Los Angeles, the Biltmore Hotel in that city quotes a special convention rate of $3.50 per person, two persons in a room, with twin beds and private bath; with an additional $1.50 per person for single room occupancy.

The Transportation Committee advises everyone going to this meeting in San Francisco to plan the trip carefully and to make all railroad and hotel reservations early.

W. R. SCOTT
Chairman of Transportation and Exhibits

WHAT TO SEE IN SAN FRANCISCO

San Francisco, city of hilltops and breath-taking views of sea and mountains, offers much to supplement the attractions of meetings and refresher courses.

Diversions to suit the taste of all are to be found. Because of the mildness of the climate, the active sports that winter precludes in many areas may be enjoyed here even in December. The metropolitan night life includes not only hotels featuring the music of the nation's best orchestras and colorful night clubs, but also numerous quaint foreign spots with their own unique atmosphere.

Among the city's sights a few that the visiting radiologist will not wish to miss may be given special mention.

SAN FRANCISCO

California Street, where East meets West. In the foreground the cable cars that climb the city's precipitous streets; in the background the San Francisco-Oakland Bay bridge, 8.5 miles long, 230 feet above the water.

Golden Gate Park, with trees, shrubs, flowers, and plants gathered from every corner of the globe.

Seal Rocks, Cliff House, and the ever-lovely beach.

San Francisco-Oakland Bay Bridge, stretching over eight miles to join San Francisco with Oakland and the other East Bay cities.

Golden Gate Bridge, the greatest single-span bridge ever constructed.

Chinatown with its shops, temples, and theaters, a strange combination of east and west, where grave representatives of an ancient civilization rub elbows with slant-eyed urchins with the latest American slang at their tongues' tips.

Fisherman's Wharf, a miniature Italian harbor, gay with life and color, where the lover of seafood may have crabs cooked to order in steaming caldrons along the sidewalks.

Aquatic Park, million-dollar bathing spot, and Yacht Harbor, filled with sailing boats and motor craft of all types, bordered by Marina Boulevard with its fine residences.

The Palace of Fine Arts, the architectural masterpiece originally built to house the art exhibits of the Panama International Exposition of 1915.

The Presidio, the U. S. military reservation of 1,540 acres, guarding the bay, now booming with activity. The old Spanish fort and Spanish guns are flanked by powerful modern guns for the protection of the city.

Coit Memorial Tower, high on Telegraph Hill, commanding a fine panoramic view and containing interesting murals depicting the city.

Twin Peaks, offering another remarkable view of the city over which they stand guard.

The Latin Quarter with its Bohemian restaurants and Italian cuisine.

Lincoln Park, western terminus of Lincoln Highway, overlooking the Golden Gate.

Fleishacker Zoo and Swimming Pool, the latter filled with heated ocean water.

Mission Dolores, founded in 1770 by the Franciscan Fathers, now housing interesting relics of Spanish California, and in striking contrast, a few blocks away, the new United States Mint, set on a Gibraltar-like eminence of solid rock.

Wherever you live, wherever you have travelled, whatever you have seen, San Francisco still offers you a new experience.

THE LOCAL COMMITTEE ON ARRANGEMENTS

GENERAL ENTERTAINMENT

Saturday, Nov. 29, at Palo Alto
Stanford-California Football Game.... 2:00 P.M.

Monday, Dec. 1, at Hotel Fairmont
Membership Dinner
Tickets to be purchased at the registration desk or at the door.

Tuesday, Dec. 2, at the Hotel Fairmont
Carman Lecture..... 8:00 P.M.

Wednesday, Dec. 3, at the Bal Tabarin Restaurant, North Beach
"Frisco Follies"..... 6:30 P.M.
An Informal Night at the Bal by the Barbary Coast, with dinner, dancing, and entertainment. Tickets, $2.25 (tax and tip included), should be secured at the Entertainment Registration Desk in the lobby before Tuesday evening, Dec. 2. Tables will be reserved only until 8:00 P.M.

Thursday, Dec. 4, at the Hotel Fairmont
President's Banquet (Formal)
Cocktails in the Terrace Ball Room (Courtesy of the Pacific Roentgen Society)..... 6:30 P.M.
Dinner, in the Terrace Ball Room..... 7:30 P.M.
Dancing..... 9:30 P.M.
Tickets, $3.00 (tax and tip included), should be secured at the Entertainment Registration Desk in the lobby before Thursday noon.

LADIES ENTERTAINMENT

Saturday, Nov. 29 at Palo Alto
Stanford-California Football Game.... 2:00 P.M.

Sunday, Nov. 30, at the Hotel Fairmont
Registration at Ladies' Registration Desk in the lobby..... 2:30 P.M.
All ladies attending the convention are requested to register. There is no charge for this service and it greatly aids the Local Committee.

Monday, Dec. 1
Registration at Ladies' Registration Desk in the lobby.....10:00 A.M.
Reception and Tea, Hotel Fairmont... 4:00 P.M.
Conducted Tour through Chinatown.. 8:00 P.M.
Tickets, fifty cents. Please make reservations before 3:00 P.M. Monday at the Ladies' Registration Desk. Meet in hotel lobby shortly before 8:00 P.M.

Tuesday, Dec. 2
Conducted Tour of the City.....11:00 A.M.
Luncheon at Lakeside Golf and Country Club..... 1:00 P.M.
Tickets, $3.00 (tour, luncheon, tax and tips included). Please make reservations before 3:00 P.M. Monday, at the Ladies' Registration Desk. Meet in lobby shortly before 11:00 A.M.
Carman Lecture..... 8:00 P.M.

Wednesday, Dec. 3
Private Shopping Trips. (Please make arrangements at the Ladies' Registration Desk.)
Tour to University of California at Berkeley and Demonstration of Cyclotron. Buses leave hotel at..... 2:30 P.M.

An aerial view of the San Francisco Bay region with Marin County in the foreground.

Please make reservations at the General Registration Desk.
Night Club Dinner-Dance (Informal).. 6:30 P.M.
See General Entertainment Program.
Thursday, Dec. 4
Drive down San Francisco Peninsula and through Stanford University Campus; Luncheon at Allied Arts Guild in Palo Alto.
Tickets for Luncheon, $1.00. Please make reservations before noon Wednesday at Ladies' Registration Desk.
Meet in hotel lobby shortly before tour starts at..... 11:00 A.M.
President's Banquet (Formal)..... 7:30 P.M.
See General Entertainment Program.

REFRESHER COURSES

Full details of the Refresher Courses to be given at the San Francisco meeting appear in the September issue of RADIOLOGY. Attention is called here to the substitution of Dr. John C. Larkin, Jr., of the Crocker Radiation Laboratory, at the University of California, for Dr. Robinson, who was to have conducted Course No. 39 on Reaction of the Skin to X-rays. Dr. Robinson has been called to active duty in the Navy.

EASTERN CONFERENCE OF RADIOLOGISTS

The New York Roentgen Society will act as host to the Eastern Conference of Radiologists meeting January 23–24, 1942. Radiologists from all parts of the country are invited to attend this meeting.

Letter to the Editor

SPINAL ARTHRITIS

To the Editor

Dear Sir:

In the June 1941 issue of RADIOLOGY there appears an editorial by Dr. Arial W. George on the subject of hypertrophic arthritis, which stirs me to make the following comments:

Hypertrophic spinal arthritis is rather like the weather; everyone talks about it but almost no one does anything about it. For many years, everyone who has had an opportunity to view routine lateral roentgenograms of the chest, routine films of the abdomen (often made incidental to urinary tract and gastro-intestinal examinations), has been struck by the fact that the great majority of people over the age of forty have small osteophytes on the

margins of the vertebral bodies. Most physicians have loosely termed these changes "hypertrophic arthritis." In his editorial Dr. George stated that these hypertrophic changes on the margins of the vertebral bodies are physiological, or at least due to normal wear and tear, and that the location of the changes away from a true joint should prevent one using the term "arthritis." He deprecated the use of the expression hypertrophic arthritis when applied to these changes, especially in industrial and medico-legal cases, and stated that "the Marie-Strümpell type of arthritis is the only true form of arthritis of the vertebrae."

Now, we beg to disagree with Dr. George on many of the points made in this editorial, but we equally agree with him in his plea for abolition of the ordinary use of the term hypertrophic arthritis in the connection referred to. Perhaps in the heat of the editorial, Dr. George overlooked the fact that hypertrophic arthritic changes can and do occur in the posterior or true articulations of the spine and, judging by the clinical behavior of hip, knee, and ankle joints, which are the seat of hypertrophic arthritis, may have considerable clinical significance. We should like to make the following points:

1. Osteophytes on the margins of the vertebral bodies should, if reported at all, be referred to as vertebral body osteophytes or hypertrophic changes; there is no justification for the use of the term hypertrophic arthritis in describing these often "physiological" spurs.

2. Osteophytes on the margins of the small joints of the spine, the posterior or zygapophysial joints, especially when associated with narrowing of those joints—as demonstrated by suitable oblique or other projections—should be referred to as degenerative or traumatic arthritis of the posterior articulations of the spine. Since the demonstration of these changes in younger subjects following trauma is quite unusual, the great majority of cases showing them may be labelled degenerative arthritis. The clinical significance of the changes is always dubious, since it is well known that degenerative arthritic changes in the non-weight-bearing joints are often asymptomatic, and even in the weight-bearing joints are not always productive of symptoms.

3. Infectious or rheumatoid arthritis involving the sacro-iliac joints and the small joints of the spine, especially when occurring in young people between the ages of twenty and forty, and associated with a history of painful or stiff back for many months, is usually due to chronic ankylosing spondylitis. The popular American name for this disorder is Marie-Strümpell arthritis. Certain types of it appear to be analogous to rheumatoid arthritis or atrophic arthritis of the extremities; other types are analogous to gonorrheal and specific bacterial forms of arthritis of the extremities, but the exact etiology of most types is unknown. We believe it important to point out that Dr. George's comments to the effect that "Marie-Strümpell arthritis is in large part the result of exposure to cold, heat, or dampness" and that "these workmen will almost certainly, after a constant occupation period of five years or more, sustain later in life some degree of arthritis of the articular processes" are not consistent with the observations of many clinicians, orthopedists, and radiologists. Marie-Strümpell arthritis is an arthritis of young adults, not elderly ones, and has not been shown by other writers to have any close connection with heat or cold.

4. Destruction of the small joints of the spine, localized to one or perhaps two joints, may be found in specific infectious types of osteo-arthritis, such as pyogenic, tuberculous, brucellous, and other forms. Therefore, true infectious osteo-arthritis of the spine may occur, although it is quite uncommon.

In summary, we believe it of great importance, both in ordinary private practice and in industrial and medico-legal practice, to avoid the use of the term hypertrophic arthritis when the only changes visible in the roentgenograms are simple vertebral body osteophytes. Conversely we regard it as important to remember the many types of true arthritis of the spine that may occur, in the recognition of which careful roentgen examination is of considerable value.

Yours very truly,

Sept. 8, 1941. L. HENRY GARLAND, M.D.

In Memoriam

CLAUDE REGAUD

1870–1940

The death of Claude Regaud, in December 1940, deprives radiology of a brilliant intellect. The loss will be keenly felt by innumerable radiologists throughout the world who had enjoyed the privilege of knowing him.

I met Dr. Regaud for the first time in January 1919 through Mme. Curie. They were both engaged then in the reorganization of the Radium Institute of the University of Paris, which had been established in 1911 but had been disrupted by the World War. I was greatly impressed by Regaud's forcefulness, sincerity, and clarity of expression. These characteristics were later reflected in the work of the Pavillon Pasteur of the Institute, which under his direction soon acquired world-wide fame.

Regaud had a keen systematic mind. By training and preference he was a histologist. He emphasized the experimental side of radiology, particularly "radiobiology"—a term which he introduced—and based his therapeutic procedures on the results of laboratory experiments. Although his deductions were not always well founded, he had great intuition, and subsequent experience has shown that on the whole he was right. He expressed his ideas with incomparable lucidity. This, coupled with the

general soundness and obvious sincerity of his convictions, won over many radiologists to his school of thought. He leaves a remarkably large following in Europe and especially in South America.

For two decades Regaud devoted all his thoughts and energy to the welfare of the institution he had built to such eminence. In his last years, which were beset with illness and grief (one of his sons died in action), he must have been cheered by the thought that the institution which he had created and nurtured with such loving care would live on. Few individuals are destined to sense this rare privilege. Radiology mourns the loss of a shining light among its eminent pioneers.

G. FAILLA

ANATOLE DESJARDINS, M.D.

1893–1941

Dr. Anatole Desjardins of Wilkes-Barre, Penna., died suddenly on Sept. 18. Dr. Desjardins was born in Maine in 1893, was graduated from Bowdoin College, served as a pharmacist in the U. S. Navy during the first World War, and subsequently received his degree in medicine from Boston University Medical School. He had been associated for fourteen years with the Wilkes-Barre General Hospital as roentgenologist. He was a diplomate of the American Board of Radiology and a member of the Pennsylvania Radiological Society and the Radiological Society of North America.

Book Review

DISEASES OF THE NAILS. By V. PARDO-CASTELLO, M.D., Assistant Professor of Dermatology and Syphilology, University of Havana, Cuba. Second Edition. With a Foreword by Howard Fox, M.D., New York. A volume of 193 pages with 98 illustrations. Published by Charles C. Thomas, Springfield, Illinois, 1941. Price $3.50.

The appearance of the second edition of this monograph five years after the first speaks well for its caliber and reflects a healthy demand for accurate knowledge in this restricted field. The text and bibliography are slightly amplified but the book remains a concise and balanced review of the subject. The contents include chapters on the anatomy and pathology of the nails, primary diseases of the nails, dystrophies, congenital abnormalities, and changes in the nails in systemic disturbances and diseases. The author speaks from a wide personal experience in Havana on the practical subject on onychomycosis. Paronychia is stressed as an important occupational disorder. Roentgen therapy is recommended, within limits, in the treatment of such conditions of the nails as psoriasis, eczema, onychomycosis, several dystrophies, verruca vulgaris, and inflammatory paronychia. There is a complete index and an abundance of excellent photographs illustrate the important affections. The volume can be highly recommended as a combination of small atlas and handy reference book.

Redwoods to the north of San Francisco

(Photograph by H. C. Tibbitts. Courtesy of Save-the-Redwoods League)

RADIOLOGICAL SOCIETIES OF NORTH AMERICA

Editor's Note.—Will secretaries of societies please cooperate with the Editor by supplying information to keep these notices accurate and up to date? Please send information to Howard P. Doub, M.D., Henry Ford Hospital, Detroit, Mich.

UNITED STATES

Radiological Society of North America.—Secretary, D. S. Childs, M.D., 607 Medical Arts Building, Syracuse, N. Y. Annual Meeting, Dec. 1–5, 1941, San Francisco, Calif.

American Roentgen Ray Society.—Secretary, C. B. Peirce, Royal Victoria Hospital, Montreal, Canada.

American College of Radiology.—Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill. Annual Meeting, 1942, Atlantic City, N. J.

Section on Radiology, American Medical Association.—Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio. Annual Meeting, 1942, Atlantic City, N. J.

CALIFORNIA

California Medical Association, Section on Radiology.—Secretary, Joseph D. Coate, M.D., 434 Thirtieth St., Oakland.

Los Angeles County Medical Association, Radiological Section.—Secretary, Wilbur Bailey, M.D., 2007 Wilshire Blvd.; Meets second Wednesday of each month at County Society Building.

Pacific Roentgen Society.—Secretary-Treasurer, L. Henry Garland, M.D., 450 Sutter St., San Francisco. Society meets annually during annual meeting of the California Medical Association.

San Francisco Radiological Society.—Secretary, J. Maurice Robinson, M.D., University of California Hospital. Meets monthly on third Thursday at 7:45 P.M., for the first six months at Toland Hall (University of California Medical School) and for the second six months at Lane Hall (Stanford University School of Medicine).

COLORADO

Denver Radiological Club.—Secretary, Paul R. Weeks, M.D., 520 Republic Bldg. Meets third Friday of each month at homes of members.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology.—Secretary-Treasurer, Max Climan, M.D., 242 Trumbull St., Hartford. Meetings bimonthly, on second Thursday. Place of meeting selected by Secretary.

FLORIDA

Florida Radiological Society.—Secretary-Treasurer, Walter A. Weed, M.D., 204 Exchange Building, Orlando. The next meeting will be at the time of the annual meeting of the Medical Association of Florida in the spring.

GEORGIA

Georgia Radiological Society.—Secretary-Treasurer, Robert C. Pendergrass, M.D., Prather Clinic Bldg., Americus. Meetings twice annually, in November and at the annual meeting of the Medical Association of Georgia in the spring.

ILLINOIS

Chicago Roentgen Society.—Secretary, Chester J. Challenger, M.D., 3117 Logan Blvd. The Society meets at the Palmer House on the second Thursday of October, November, January, February, March, and April.

Illinois Radiological Society.—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

Illinois State Medical Society, Section on Radiology.—Secretary, Earl E. Barth, M.D., 303 E. Chicago Ave., Chicago.

INDIANA

The Indiana Roentgen Society.—Secretary-Treasurer, Harold C. Ochsner, Methodist Hospital, Indianapolis. Annual meeting in May.

IOWA

The Iowa X-ray Club.—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

KENTUCKY

Kentucky Radiological Society.—Secretary-Treasurer, Joseph C. Bell, M.D., 402 Heyburn Bldg., Louisville. Meeting annually in Louisville, third Sunday afternoon in April.

LOUISIANA

Louisiana Radiological Society.—Secretary-Treasurer, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society. Next meeting, New Orleans, April 1942.

Shreveport Radiological Club.—Secretary-Treasurer, W. R. Harwell, M.D. Meetings monthly on the second Wednesday, at the offices of the various members.

MARYLAND

Baltimore City Medical Society, Radiological Section.—Secretary, Walter L. Kilby, M.D., 101 W. Read St. Meetings are held the third Tuesday of each month.

MICHIGAN

Detroit X-ray and Radium Society.—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

Michigan Association of Roentgenologists.—Secretary-Treasurer, J. E. Lofstrom, M.D., St. Mary's Hospital, Detroit. Meetings quarterly by announcement.

MINNESOTA

Minnesota Radiological Society.—Secretary, John P. Medelman, M.D., 572 Lowry Medical Arts Bldg., St. Paul. Meetings quarterly.

MISSOURI

The Kansas City Radiological Society.—Secretary, P. E. Hiebert, M.D., 907 North Seventh St. (Huron Bldg.), Kansas City, Kansas. Meetings last Thursday of each month.

The St. Louis Society of Radiologists.—Secretary, Wilbur K. Mueller, M.D., University Club Bldg. Meets on fourth Wednesday of October, January, March, and May, at a place designated by the president.

NEBRASKA

Nebraska Radiological Society.—Secretary, D. A. Dowell, M.D., 816 Medical Arts Bldg., Omaha. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

NEW ENGLAND

New England Roentgen Ray Society (Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island).—*Secretary,* Hugh F. Hare, M.D., Lahey Clinic, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

NEW JERSEY

Radiological Society of New Jersey.—Secretary, H. J. Perlberg, M.D., Trust Co. of New Jersey Bldg., Jersey City. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called by president.

NEW YORK

Associated Radiologists of New York, Inc.—Secretary, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

Brooklyn Roentgen Ray Society.—Secretary-Treasurer, Leo Harrington, M.D., 880 Ocean Ave. Meetings held the fourth Tuesday of every month, October to April.

Buffalo Radiological Society.—Secretary-Treasurer, Joseph S. Gianfranceschi, M.D., 610 Niagara St. Meetings second Monday evening each month, October to May, inclusive.

Central New York Roentgen Ray Society.—Secretary-Treasurer, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings are held in January, May, and October, as called by Executive Committee.

Long Island Radiological Society.—Secretary, Marcus Wiener, M.D., 1430 48th St., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—Secretary, Paul C. Swenson, M.D., Presbyterian Hospital, New York, N. Y.

Rochester Roentgen-ray Society.—Secretary, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

NORTH CAROLINA

Radiological Society of North Carolina.—Secretary-Treasurer, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meeting with State meeting in May, and meeting in October.

NORTH DAKOTA

North Dakota Radiological Society.—Secretary, L. A. Nash, M.D., St. John's Hospital, Fargo. Meetings by announcement.

OHIO

Ohio Radiological Society.—Secretary, J. E. McCarthy, M.D., Cincinnati. The next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

Cleveland Radiological Society.—Secretary-Treasurer, J. O. Newton, M.D., 13921 Terrace Road, East Cleveland. Meetings at 6:30 P.M. at the Mid-day Club, in the Union Commerce Bldg., on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*Secretary-Treasurer,* Justin E. McCarthy, M.D., 707 Race St. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport. The Society meets annually; time and place of next meeting will be announced later.

The Philadelphia Roentgen Ray Society.—Secretary, Barton R. Young, M.D., Temple University Hospital, Philadelphia. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22nd St., Philadelphia.

The Pittsburgh Roentgen Society.—Secretary-Treasurer, Harold W. Jacox, M.D., 4800 Friendship Ave., Pittsburgh, Pa. Meetings are held on the second Wednesday of each month at 4:30 P.M., from October to June, at the Pittsburgh Academy of Medicine, 322 N. Craig St.

ROCKY MOUNTAIN STATES

Rocky Mountain Radiological Society (North Dakota, South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—*Secretary,* A. M. Popma, M.D., 220 North First St., Boise, Idaho.

SOUTH CAROLINA

South Carolina X-ray Society.—Secretary-Treasurer, Malcolm Mosteller, M.D., Columbia Hospital, Columbia. Meetings in Charleston on first Thursday in November, also at time and place of South Carolina, State Medical Association.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee Radiological Society.—Secretary-Treasurer, Franklin B. Bogart, M.D., 311 Medical Arts Bldg., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Texas Radiological Society.—Secretary-Treasurer, L. W. Baird, M.D., Scott and White Hospital, Temple. Meets annually.

VIRGINIA

Virginia Radiological Society.—Secretary, Charles H. Peterson, M.D., 603 Medical Arts Bldg., Roanoke.

WASHINGTON

Washington State Radiological Society.—Secretary-Treasurer, Kenneth J. Holtz, M.D., American Bank Bldg., Seattle. Meetings fourth Monday of each month at College Club, Seattle.

WISCONSIN

Milwaukee, Roentgen Ray Society.—Secretary-Treasurer, Irving I. Cowan, M.D., Mount Sinai Hospital, Milwaukee. Meets monthly on first Friday at the University Club.

Radiological Section of the Wisconsin State Medical Society.—Secretary, Russel F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

University of Wisconsin Radiological Conference.—Secretary, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

CANADA

Section on Radiology, Canadian Medical Association.—Secretary, W. J. Cryderman, M.D., Medical Arts Bldg., Toronto.

Section on Radiology, Ontario Medical Association.—Secretary, W. J. Cryderman, M.D., 474 Glenlake Avenue, Toronto.

Canadian Association of Radiologists.—Honorary Secretary-Treasurer, A. C. Singleton, M.D., Toronto.

La Société Canadienne-Française d'Eléctrologie et de Radiologie Médicales.—General Secretary, Origène Dufresne, M.D., Institut du Radium, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

CUBA

Sociedad de Radiología y Fisioterapia de Cuba.—Offices in Hospital Mercedes, Havana. Meetings are held monthly.

ABSTRACTS OF CURRENT LITERATURE

ROENTGEN DIAGNOSIS

The Head and Neck

The Chest

The Digestive Tract

The Skeletal System

The Genito-Urinary Tract

Gynecology and Obstetrics

The Spinal Cord

The Circulatory System

ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Radiological Study of Tumors of the Jaw. Carlo Bignami. Radiol. med. **28:** 167–183, March 1941.

Bignami classifies neoplasms of the jaw as those having a dental origin and those developing from the osseous tissue, and presents an excellent description of the radiological picture of the various tumors occurring in this location. Good roentgenograms illustrate the text.

A case of melanosarcoma is included. Attention is called to the rarity of Ewing's tumor and myeloma of the jaw. A. MAYORAL, M.D.

Roentgenoscopy of the Pharynx in Myasthenia Gravis Before and After Prostigmine Injection. Robert S. Schwab and Henry R. Viets. Am. J. Roentgenol. **45:** 357–359, March 1941.

The observation of the swallowing reflex in patients with dysphagia due to myasthenia gravis, by barium ingestion, is a simple and valuable form of the "prostigmine test." Barium is quickly swallowed after the proper amount of prostigmine is injected in cases of myasthenia gravis, but no such improvement is observed in other diseases. Of 19 cases examined by this method 17 responded so strikingly that no barium was retained in the pharynx.

As the myasthenia gravis patient with dysphagia is often gravely ill, the test is done in the hospital and prostigmine is kept ready in case of respiratory failure during the initial swallowing before the injection.

S. M. ATKINS, M.D.

Cerebral Hemiatrophy with Compensatory Homolateral Hypertrophy of the Skull and Sinuses, and Diminution of Cranial Volume. Alexander T. Ross. Am. J. Roentgenol. **45:** 332–341, March 1941.

Thirty-six patients with hemiplegia and convulsions at the Caro State Hospital for Epileptics (Michigan) form the basis of this report. In 25 hemiplegia developed before the second year, in 7 between the second and seventh, and in 4 between the eighth and thirteenth years.

The series includes 24 instances of thickening of the cranial vault of varying degree, 19 of over-development of the nasal sinuses, usually the supraorbital air cells, and 9 cases in which the affected side of the skull was smaller in volume than its counterpart. These changes occur on the affected side but are not necessarily present in every instance of cerebral hemiatrophy; in fact, in two instances the skull overlying the affected brain was thinner. S. M. ATKINS, M.D.

Roentgen Appearance of Meningioma of the Tentorium. Erik Lysholm. Acta Radiol. **22:** 303–317, March 1941.

The x-ray appearance of meningioma of the tentorium depends to a large degree on the location of the tumor. When the tumor originates in the lateral portion of the lower aspect of the tentorium without penetration through the tentorium and without bulging into the middle fossa, only a general localization is possible. The deformity of the fourth ventricle, observed in these cases, is identical with that seen in cerebellar tumors. Only if calcifications typical of meningioma are present can an exact diagnosis be made. The same observation applies to meningiomas of the mid-line unless the tumor extends to the middle fossa. If, however, the tumor has penetrated from the mid-line through the tentorial fissure, the diagnosis of meningioma of the tentorium may be made on the basis of the typical deformities in the ventriculographic picture. While the appearance is similar to that which was previously described by the author for tumors above the fastigium, it must be noted that the supratentorial portion of the aqueduct and the lower part of the third ventricle fail to show the typical supratentorial deformity and kinking but, instead, there is a forward displacement of the aqueduct. The lower portion of the third ventricle shows a rounded impression and some anterior displacement. Another group of cases show both occipital and subtentorial changes with dumbbell shaped tumor formation visible in the aqueduct, the third and lateral ventricles.

The different locations of the meningiomas of the tentorium are discussed by means of illustrative cases, and the necessity of an examination not only of the lateral ventricles but also of the third and fourth ventricles is emphasized. ERNST A. SCHMIDT, M.D.

Roentgenologic Views on Basilar Impression. E. Lindgren. Acta Radiol. **22:** 297–302, March 1941.

Lindgren describes as basilar impression "a condition where the floor of the posterior fossa of the skull around the foramen magnum, especially in its anterior and lateral areas, is pressed toward the interior of the skull." French authors have used the terms *déformation plastique du crâne* and *aplatissement de la base du crâne;* the German equivalents are *plastische Deformation* and *Platybasie.*

The deformities may be primary (idiopathic), as in the 9 cases discussed by the author, or they may be secondary and incidental to skeletal diseases, *e.g.,* rickets, osteomalacia, osteitis deformans, lipoidosis, tuberculosis, senile osteoporosis, osteopsathyrosis congenita, and cleido-cranial dysostosis.

While in lateral roentgenograms measurement of Martin's angles (as used in anthropologic research) shows any deviation from the normal, it is advisable to study the relations of the condyloid area of the occipital bone in the anteroposterior view since the earliest changes are located in this area.

ERNST A. SCHMIDT, M.D.

THE CHEST

Bilateral Pneumothorax: Review of 56 Cases. Robert M. Sonneborn. West Virginia M. J. **37:** 97–106, March 1941.

Only during the last ten years has bilateral pneumothorax been used and reported in the American literature. It is difficult to analyze reported results because of the great variability in classification and nomenclature and the insufficient descriptions.

In evaluating results in this paper, the criteria necessary to classify a case as inactive are (1) a negative sputum on repeated concentrated examinations, and cultures when indicated; (2) absence of cavity; (3) a stable or regressive x-ray appearance; (4) absence of constitutional symptoms.

The greater the extent of the disease, the poorer the result regardless of the type of therapy. Hence, in classifying results the amount of disease in each lung should be considered, and the type of disease predominating, such as exudative or fibrocavernous, and complications should be taken into consideration.

Bilateral pneumothorax may be divided into two groups: simultaneous collapse and consecutive collapse. Indications are: advanced bilateral disease, preferably localized, where one side can be controlled and sufficient good lung remains uncollapsed to provide adequately for respiration; extension of disease on the

contralateral side during the course of a unilateral pneumothorax, or where the contralateral side presents an unstable lesion, especially in those cases which do not respond to further strict rest or phrenic nerve surgery; uncontrollable hemorrhage from the contralateral side during the course of a unilateral pneumothorax.

Fifty-six cases are reported, 40 in females and 16 in males, treated from January 1935 to July 1, 1940; 93 per cent of the cases were far advanced and 7 per cent moderately advanced. The average age was twenty-three, but the range was from ten to fifty-three. The interval between institution of pneumothorax on the two sides varied from eleven days to fifty-five months, and averaged sixteen months. Crushing of the phrenic nerve and pneumolysis were added when necessary. All patients received complete bed rest.

Of the 56 cases, 19 are inactive; 2 additional cases have active bronchitis with positive sputum but apparently controlled parenchymal lesions, and 6 have become inactive with additional procedures after reexpansion of the uncontrolled but improved lung. Thirteen patients are dead; 16 are alive with active disease.

Over half of the 56 patients had far-advanced disease in each lung; in 10 of these the disease is inactive as result of pneumothorax and in 2 others following pneumothorax with additional treatment.

Twenty patients had far-advanced disease in one lung and moderately advanced disease in the other lung. Seven of these cases are inactive; in 2 there are inactive parenchymal lesions but active bronchitis; and 4 have become inactive as the result of additional procedures.

Of 3 cases with moderate disease on both sides, 2 became inactive.

The more favorable results were obtained when the first side was controlled before attempting collapse of the second side. Results were better in patients whose general condition was more favorable. Basal lesions responded less favorably than others. Complications occurred in 39 per cent of the series. They included massive spontaneous pneumothorax, serofibrinous effusion, bronchopleural fistula, pleurocutaneous fistula, and one air embolism.

Associated diseases were tuberculous meningitis, tuberculous bronchitis, tuberculous enteritis, tuberculosis of the spine, middle ear, cervical lymph nodes, tubes, and ovaries. None of these was considered a contraindication to treatment.

The author concludes that bilateral pneumothorax is of definite value in pulmonary tuberculosis with bilateral involvement, particularly when the disease is moderately or far advanced in each lung or far advanced in one and moderately in the other. The results vary in inverse proportion to the extent of the disease. Other procedures are to be used as indicated.

JOHN E. WHITELEATHER, M.D.

On the Radiological Aspects of an Investigation into the Relationship of Chronic Irido-Cyclitis, Uveo-Parotitis and Tuberculosis. E. R. Williams. Brit. J. Radiol. **14:** 116–127, April 1941.

Forty patients with chronic irido-cyclitis and uveoparotitis were investigated. In 25 definite evidence of tuberculosis was found. This is regarded as evidence that there is a relationship between tuberculosis and these two diseases. Reports of six of the cases are included, and 18 chest roentgenograms are reproduced.

SYDNEY J. HAWLEY, M.D.

Traumatic Bronchostenosis and Its Treatment. W. Löffler and F. Nager. Schweiz. med. Wchnschr. **71:** 293–297, March 15, 1941.

A female aged 31 sustained a severe crushing injury to the chest plus other injuries in an automobile accident on Sept. 9, 1938. Although immediate recovery was fair, fever and dyspnea continued and a tomogram in April 1939 showed a severe stenosis of the right main bronchus 2 cm. below the bifurcation. Bronchoscopy on May 4 showed that this was wider open on inspiration than on expiration. After a continued stormy course, during which the right lung became completely atelectatic, the stricture was dilated with esophageal sounds. When this failed to produce further improvement, the edges of the stricture were trimmed with electrocoagulation and the stenosis dilated by electrolysis. Further bouginage was later employed. The course continued stormy, but after a year there was only moderate stenosis with clearing of the atelectasis but a residual bronchiectasis. The patient eventually returned to her work. The article is well illustrated.

LEWIS G. JACOBS, M.D.

Roentgenoscopy as a Diagnostic Aid in Coronary Occlusion. Arthur M. Master. Am. J. Roentgenol. **45:** 350–356, March 1941.

Roentgenoscopically a localized systolic expansion of the left ventricular border is characteristic if not pathognomonic of myocardial infarction due to coronary occlusion. It is found in 50 per cent of cases whether early or late after the attack. This report is based on a study of 300 patients seen in private practice.

After a general survey of the heart and lungs the left cardiac border was studied for the time relation between the aortic and left ventricular pulsations. This latter was observed with respiration suspended after a moderate deep inspiration without straining. The postero-anterior view is usually the best, but the left oblique and left lateral were also studied.

Besides systolic expansion, most characteristic of this condition, reversal of pulsation is often seen as a wavelike movement of the left ventricular border. Occasionally the systolic expansion is incomplete and appears as a localized lag, that is, the infarcted portion does not begin to contract until after the beginning of systole. Another variation of incomplete systolic expansion is "doubling" of pulsation, a contraction followed by a halt, and then another contraction. Less significant, but still abnormal, is localized absence or diminution of pulsation, which may occur in other types of heart disease.

Ventricular contraction was abnormal in 67 per cent of the series with complete or partial systolic expansion in 43 per cent and diminution or absence in 24 per cent. These phenomena were never observed in 42 control normal hearts. In coronary disease without occlusion reversal or absence of pulsation was entirely lacking.

In 83 per cent of the cases the abnormal pulsation was in the apex, in 15 per cent only in the middle third. The site of the infarction appeared to play no part in the incidence of abnormal pulsations. Cardiac enlargement increases the incidence of systolic expansion.

This abnormal pulsation occurs directly after the attack in most cases and has been seen as long as fourteen years afterward. A change from reversal to absence or diminution of pulsation probably indicates some return of contractility and hence improvement, though improvement may be present despite persistence of the reversed pulsation.

S. M. ATKINS, M.D.

Roentgenologic Studies of the Size of the Heart in Childhood. Helen B. Taussig and Marcel Goldenberg. Am. Heart J. **21:** 440–449, April 1941.

By superimposing teleroentgenograms taken during the clinical course of rheumatic fever, the authors found the heart size either increased normally after a period of enlargement, remained stationary while the chest grew, or enlarged progressively. The behavior of

the heart shadow was better correlated with the activity of the rheumatic infection than with the type of valvular lesion present. The inference is drawn that myocardial damage rather than the valvular lesions is responsible for cardiac hypertrophy in rheumatic fever. It is also inferred that lack of cardiac enlargement during periods of active infection is brought about by bed rest, which decreases the load upon the heart. The mortality was four times higher in the group showing cardiac enlargement and this group contained five times as many invalids. Ziskin's *Ungerleider* and Clark's normal standards were used in this study.

WM. H. GILLENTINE, M.D.

Thymic Malignancy. James L. Wade and A. R. K. Mathews. West Virginia M. J. **37:** 107–113, March 1941.

The thymus is rarely the seat of primary new growth and very rarely the site of metastasis from neoplasms elsewhere. Certain symptoms predominate and seem to be definitely related to pressure and displacement of the structures of the anterior and superior mediastinum. The symptoms may be acute and fulminating or insidious. In order of their frequency they are cough, dyspnea or orthopnea, hoarseness, and a visible swelling or puffiness of the neck, face, or arm. There may be cyanosis of the lips and finger nails and the veins of the neck are often prominent. Dyspnea is an almost constant finding and there are symptoms due to pressure and displacement of the trachea and recurrent laryngeal nerve, most marked in the left recumbent position. Later there may be pleural and pericardial effusion. Pain is not a striking feature.

The findings on physical examination depend on the size of the growth. With a small growth there may be no physical signs. It may be possible to determine the size of the tumor and the presence of fluid in the pleural cavity by percussion. A diagnostic thoracentesis should be done; the presence of blood-tinged fluid is viewed as highly significant. There may be ascites and peripheral edema.

The authors record the case of a five-year-old girl, normal since birth, but complaining of distress and fullness in the epigastrium of about one month's duration. There was distinct displacement of the cardiac apex toward the right, with moderate cyanosis. The dyspnea had evidently been of a paroxysmal type, aggravated by lying on the left side. There was slight cyanosis of the lips and finger nails and the face and neck were puffy on the left side. There was no Horner syndrome, no adenopathy, no venous distention. The left thoracic cage was bulging. There was obliteration of the interspaces and no expansion. The percussion note was flat over the entire chest with absence of vocal fremitus and breath sounds. The trachea was displaced to the right. An area of dullness was found just to the left of the mid-line in the third and fourth interspaces. No heart sounds were heard over the left chest. A loud systolic bruit was heard over the right third interspace radiating to the vessels in the neck. Blood pressure was slightly different in the two arms. Considerable bloody fluid was withdrawn from the pleura and pericardium. This was negative on culture and no malignant cells were present.

Autopsy showed cervical, axillary, and inguinal lymphadenopathy. The left chest was filled with yellow fluid and the left lung collapsed. The heart was pushed to the right and the pericardium was filled with yellowish fluid. A large tumor occupied the upper and left medial portion of the mediastinum, extending downward over the left lung, to which it was firmly adherent, over the pericardium, and on to the left diaphragm. It weighed 225 gm. and was composed of round cells with scanty cytoplasm and large dark nuclei of the lymphoid type, probably arising from the reticulum. There were no giant cells, Hassall's bodies, nor distant metastases.

JOHN E. WHITELEATHER, M.D.

THE DIGESTIVE TRACT

Esophageal Obstruction due to Gummata of Esophagus and Diaphragm. R. H. Kampmeier and E. Jones. Am. J. M. Sc. **201:** 539–546, April 1941.

Four cases are reported of obstruction of the esophagus due to gummata. In one case the lesion involved the esophageal wall. In the remaining cases the gummata affected the diaphragm at or about the esophageal hiatus.

Only esophagoscopy and biopsy can differentiate this lesion from carcinoma or cardiospasm. Although antisyphilitic therapy may serve to increase the obstruction by causing additional fibrosis, it should, nevertheless, be administered in every case in which syphilis is suspected.

Since gummatous lesions are rare, there is a great probability that the obstructing lesion may be a carcinoma. An accurate diagnosis is important in view of the difference in prognosis. One case did not receive the benefit of specific therapy because of a mistaken diagnosis of cancer, and death ensued. The other three patients did well under antisyphilitic treatment.

BENJAMIN COPLEMAN, M.D.

Radiologic Investigation of Dyspeptic Soldiers. R. Saffley. Brit. J. Radiol. **14:** 96–101, March 1941.

The results of the examination of 320 soldiers suffering from dyspepsia are given: 161 were found normal, 111 showed duodenal ulcer, 13 gastric ulcer, 7 duodenitis, 5 gastritis, 5 duodenal ileus, and 18 miscellaneous conditions. Three in the normal group were found to have gastro-enterostomies, but showed no evidence of disease. In all those with a diagnosis of duodenal ulcer and gastric ulcer a niche was observed. The group classed as duodenitis included those with a duodenal deformity without evidence of a niche. The cases classed as gastritis showed hypertrophy of the rugae. The diagnosis of duodenal ileus was made only when the variation from normal was very great. The miscellaneous group included cases showing deformity due to an apparently healed duodenal ulcer, gastroenterostomies with evidence of ulcer or inflammation at the stoma, and one case of achalasia of the cardia.

SYDNEY J. HAWLEY, M.D.

Radiological Evidence of Gastrocolic Fistula. Angelo Gregori. Radiol. med. **27:** 795–802, October 1940.

Gregori reports a case of gastrocolic fistula in a sixty-year-old patient whose only complaints were tenderness over the umbilicus on deep palpation and progressive weakness. Roentgen examination revealed a direct communication between the stomach and transverse colon and a filling defect in the stomach. The final diagnosis was gastrocolic fistula subsequent to a malignant gastric neoplasm.

A. MAYORAL, M.D.

Intussusception of the Jejunum due to Carcinoid Tumor. S. Mufson and E. A. Horowitz. New England J. Med. **224:** 602–604, April 3, 1941.

Carcinoid tumor is the name given by Oberndorfer to growths arising from the Kultschitzky cells in the wall of the crypts of Lieberkühn, which are related to the cells of the chromaffin system. They are also known as argentaffin tumors. Usually these growths are benign, but about 25 per cent metastasize.

Intussusception is uncommon in the adult but when it occurs it is usually found to be due to a tumor, and this is most frequently benign. Tumors of the small bowel comprise about 9 per cent of all the tumors of the gastro-intestinal tract, and of these about 5 per cent are malignant.

There have been reported 237 carcinoid tumors of the small intestine but none of these produced intus-

susception. Special interest thus attaches to this report of a nineteen-year-old female with symptoms of intestinal obstruction, in whom operation revealed a jejunojejunal intussusception caused by a carcinoid tumor. The mass was resected and the patient recovered. JOHN MCANENY, M.D.

Combination of Cholecystography and Barium Meal Examination. The Economical and Practical Value. A. S. Johnstone. Brit. J. Radiol. **14:** 107–109, March 1941.

By combining the barium meal examination and cholecystography the number of visits of the patient may be decreased, and by judicious use of the fluoroscope the number of films required may be materially reduced. This combination is also practical from the standpoint of more accurate upper abdominal diagnosis.

Of 57 patients referred for cholecystography, 32 were found to have pathological gallbladders and 25 normal cholecystograms. In the former group one duodenal ulcer was found and one patient had pleurisy with effusion. Among the 25 patients with normal cholecystographic findings, 11 active duodenal ulcers were found, 1 duodenal diverticulum, and 1 pleural effusion. Of 30 patients with vague clinical pictures, 6 gave cholecystographic evidence of disease, and of these 1 had a duodenal ulcer and 1 a diverticulosis of the colon. Among the 24 who had normally functioning gallbladders, 7 had duodenal ulcers, 1 had a small duodenal diverticulum, 2 had gastric ulcers, and 1 had a gastric carcinoma. SYDNEY J. HAWLEY, M.D.

A Diverticulum-Like Formation of the Common Bile Duct Demonstrated by Cholangiography. Sven Erik Sjögren. Acta Radiol. **22:** 318–326, March 1941.

Among the anomalies of the biliary system, diverticula of the ducts are rather rare and, as a rule, escape roentgenologic diagnosis.

Sjögren describes the case of a 49-year-old woman whose gallbladder had been removed five years previously on account of cholelithiasis. A later laparotomy, which appeared indicated in view of recurring colicky pains, had failed to show any pathologic changes except for abdominal adhesions. As the symptoms persisted, a third operation was performed, during which probing of the common bile duct revealed a pouch in the posterior wall. Cholangiography with Perabrodil outlined a cyst-like formation measuring about 4 × 3 cm.

The author discusses similar abnormalities of the bile ducts with which the reported formation might be confused, especially the congenital idiopathic choledochus dilatation (or choledochus cyst), often called "diverticulum of the common bile duct," particularly in the Anglo-American medical literature.

ERNST A. SCHMIDT, M.D.

THE SKELETAL SYSTEM

Roentgenographic Study of the Carpal Canal. V. L. Hart and V. Gaynor. J. Bone & Joint Surg. **23:** 382, April 1941.

The carpal canal is a groove on the palmar surface of the wrist bounded on the ulnar side by the hook of the hamate and the pisiform bone and on the radial side by the prow of the navicular and the crest of the greater multangular. These projections are joined by ligaments which form the roof of the canal, through which run the deep flexor tendons, nerves, and vessels.

Limited radiological knowledge of this canal is to be found and a position for viewing it is presented. Special equipment consists in a 10-inch length of light board with a hole at either end for a string sufficiently long to pass about the neck, when the flexor surfaces of the fingers of both hands are pressed against the board. With the flexor surfaces of both forearms resting on the table the central ray of the x-ray tube is directed along the palmar surface of the wrists, which are held in extreme extension by the board and cord around the neck. Good views of the carpal canals are obtained.

J. B. MCANENY, M.D.

Arthrographic Studies on the Ankle Joint. C. J. Hansson. Acta Radiol. **22:** 281–287, March 1941.

Arthrography by means of a contrast medium (3 c.c. of a 35 per cent solution of Perabrodil after local anesthesia) is especially valuable in the roentgen demonstration of ruptures of the ligaments, of the joint capsule, or of the syndesmosis. The method proved that the unsteadiness occasionally seen in the ankle after injury may be due not only to changes in the talo-crural joint proper but also to ligamental attrition in the posterior talo-calcaneal junction. Roentgenograms are reproduced. ERNST A. SCHMIDT, M.D.

Value of Arthrography of the Shoulder Joint. Oliver Axén. Acta Radiol. **22:** 268–276, March 1941.

Axén reports his experiences in 173 instances of arthrography of the shoulder joint which were observed in the Serafimer Hospital of Stockholm from 1938 to 1940. The technic consisted in the intra-articular injection of 6 to 8 c.c. of Perabrodil (35 per cent) after local aethocain anesthesia. Roentgenograms were taken in adduction, abduction, and rotation of the humerus, with the patient both recumbent and erect. The method was found to be of special value for the diagnosis of ruptures of the joint capsule and of the tendon of the caput longum of the biceps muscle. Communication between the joint space and the subacromial bursa was demonstrated in a similar percentage of men and women above the age of forty years without history of injury or clinical symptoms. Roentgenograms are reproduced. ERNST A. SCHMIDT, M.D.

Fractures in the Neck of the Femur in Children, with Particular Reference to Aseptic Necrosis. B. Carrell and W. B. Carrell. J. Bone & Joint Surg. **23:** 225, April 1941.

Twelve cases of fracture of the femoral neck in children are the subject of this analysis. It is an unusual injury at this period of life but does occur from severe trauma. Usually the fracture is in the cervicotrochanteric region. All methods of reduction and fixation have been used, but the most satisfactory procedure seems to be wide abduction and fixation in plaster. Occasionally the adductors must be tenotomized to permit sufficient abduction.

Aseptic necrosis occurred in one-third of the cases. To prevent this complication, gentle manipulation and a long period of non-weight bearing are recommended.

This article is accompanied by several excellent roentgenographic reproductions.

J. B. MCANENY, M.D.

Fatigue Fracture of the Fibula in an Industrial Worker. M. Detlefsen. München. med. Wchnschr. **88:** 303–305, March 14, 1941.

A thirty-seven-year-old woman who operated a motor-driven sewing machine suffered for six months from pain in her left leg above the ankle, aggravated by her work at the machine. A roentgenogram showed a fracture of the fibula with slight callus formation just above the malleolus. The right ankle was normal. A check-up examination two years later showed complete healing. There was no antecedent history of injury, and the fracture is believed to have been due to the chronic

trauma from the vibration of the machine, with the resultant formation of a fragmentation zone.

LEWIS G. JACOBS, M.D.

Slipping of the Upper Femoral Epiphysis. End Results after Conservative Treatment. M. Forrester Brown. J. Bone & Joint Surg. **23:** 256, April 1941.

The author does not claim for the method of treatment of slipping femoral epiphysis here discussed that it will produce perfect anatomical reduction but rather that the results are equal to those of operative reduction.

The basic deformity is the bending of the femoral head backward on the neck with twisting of the cartilage. Metabolic disturbances may be at work necessitating the use of thyroid and pituitary preparations. The most frequent age of onset is between twelve and fifteen years. The exact time of onset is difficult to establish because bone softening is usually present for some time before slipping takes place and before the patient complains. Bone softening is suggested by the frequent presence of knock-knees.

Under general anesthesia and with the method of Leadbetter in mind, the hip is brought into full internal rotation, usually after flexion and adduction of the hip. Position is maintained by plaster and the patient is returned home for three months, after which interval an x-ray examination of the hip is made and a new cast is applied. This treatment is continued until the epiphyseal line is crossed by trabeculae. This may require from three to twelve months.

All the patients in the author's findings walked with normal attitude, and though they had some limitation of flexion could sit without discomfort. Some had limitation of abduction and adduction and external rotation. Most of the patients were able to work at gainful occupations without difficulty; others were at school or worked at home.

J. B. MCANENY, M.D.

Complete Bilateral Epiphyseal Separation of the Upper Humeral Epiphyses due to Scurvy. R. T. Hudson, D. C. Hucherson, and A. B. Ortner. J. Bone & Joint Surg. **23:** 375, April 1941.

This is a case report of a nine-months-old white girl whose diet was limited to diluted condensed milk, with no fruit juice, cod-liver oil, cereals, or vegetables. Just before examination swelling of the lower extremities and marked enlargements at both shoulders developed. The child resented handling and was nervous.

Films of the shoulders showed separation of the humeral shafts laterally at the epiphyseal lines surrounded by calcifying hemorrhages. There were also subperiosteal hemorrhages beneath the femora, tibiae, and fibulae. Good reproductions of the films are presented.

J. B. MCANENY, M.D.

Epiphyseal Dislocations in Scurvy. W. Scott. J. Bone & Joint Surg. **23:** 314, April 1941.

Spontaneous epiphysiolysis has been known for a long time and described by many writers. Hypovitaminosis C with hemorrhage and secondary anemia form the basis of the disorder. The responsible factors in this state are increased demands for vitamin C, abnormal destruction of the vitamin, decreased absorbability and hypersensitivity for the vitamin.

The vulnerable region in scurvy is at the narrow white line at the end of the metaphysis, the *Trümmerfeld*. This is due to the high lime content, where numerous microscopic fracture lines can be seen. Epiphyseal dislocation in scurvy seems to be due to two factors, the spontaneous lattice fractures and subperiosteal hemorrhage.

The two cases reported showed epiphyseal dislocation of the shaft through the periosteum, with hemorrhage in the subperiosteal space, where calcification later occurred with eventual reconstruction of the original alignment of the bone.

Several well taken points are brought out in this paper. When subperiosteal hemorrhage is visible, it is calcified and in a healing state, therefore a late phenomenon. Epiphyseal dislocations and subluxations are likewise late manifestations. Most important of all, calcified subperiosteal hematomata and dislocated epiphyses are not pathognomonic signs of scurvy unless they are accompanied by the scorbutic white lines.

J. B. MCANENY, M.D.

Polyostotic Fibrous Dysplasia with Cutaneous Pigmentation and Congenital Arteriovenous Aneurysms. H. M. Stauffer, R. K. Arbuckle, and E. E. Aegerter. J. Bone & Joint Surg. **23:** 323–334, April 1941.

Fibrous dystrophy involving the bones, accompanied by cutaneous pigmentation, has frequently been reported of late. The case recorded here presents the additional complication of arteriovenous aneurysm. Venous dilatation was noticed in the left upper extremity during early childhood, and at ten years the heart was discovered to be enlarged. When the patient was examined, at nineteen years of age, there was obvious deformity of the entire left side of the body. Except for the right lower extremity the entire skeleton was abnormal, more so on the left side. The skull showed thickening of the frontal bones with irregularity in density. This process also involved the floor of the skull in the anterior and middle fossae. The left humerus was greatly expanded, with a thin, irregular cortex, the medullary portion showing coarse irregular trabeculations of increased density surrounding less dense areas simulating cysts. The bones of the left hand, the left side of the pelvis, left lower extremity, right upper extremity, mandible, several ribs, and some vertebrae were also involved.

There was a large coffee-colored pigmented area in the mid-back, just to the left of the mid-line.

There was a congenital arteriovenous aneurysm of the left upper extremity and a similar condition was strongly suspected in the left lower extremity.

J. B. MCANENY, M.D.

Generalized Osteochondritis. Tommaso Lucherini and Elio Giacobini. Radiol. med. **28:** 141–166, March 1941.

Lucherini and Giacobini, in an extensive and well illustrated article, present 4 cases of generalized osteochondritis in siblings, 2 females and 2 males born of healthy parents. The two older as well as the youngest of the family of 7 children were free from any skeletal or other anatomical changes.

The authors believe that their four patients present a new and important syndrome, characterized by alterations in ossification of cartilage, endocrine changes causing early development of the genitals, and a familial character. Because of the similarity of the cases, and after an extensive differential study of the other types of osteochondritic dysplasias, the writers advance the hypothesis that these conditions are due to changes in the endocrine glands.

A. MAYORAL, M.D.

Dwarfism. August A. Werner. J. Missouri M. A. **38:** 75–82, March 1941.

Dwarfism may be classified as non-endocrine and endocrine. Among the non-endocrine forms are achondroplasia and rickets. In the former, the condition has its onset in early fetal life with the first development of cartilage. This form of dwarfism is character-

ized by delayed and abnormal growth of the epiphyses of the long bones, resulting in a trunk of relatively normal size and short extremities. Heredity and prenatal factors seem to play a dominant rôle here. The condition is relatively rare; in most instances death occurs before birth and the majority of those living at birth succumb in early infancy. Those who survive the first year of life usually have a normal life expectancy.

Rickets usually occurs in infancy and early childhood and is caused by a deficiency of vitamin D in the diet. The fundamental feature is a disturbance of calcium and phosphorus metabolism with consequent defective growth and development of bone. [The author does not mention renal rickets or renal dwarfism.]

The endocrine glands that are particularly involved in the production of dwarfism are the anterior pituitary, the gonads, the thyroid, and the pineal. Pituitary dwarfism (infantilism) is characterized by failure of somatic and sexual development due to insufficient secretion of growth-stimulating hormone from the anterior pituitary lobe. Development is arrested uniformly so that relative proportions are observed. Mentality is usually normal. A condition which may be confused with pituitary dwarfism is hereditary smallness or microsomia. These children are small because of inherited characteristics and are otherwise normal, with normally developing sex functions. There is no apparent glandular disturbance and no treatment is required.

Gonadal dwarfism is not due to insufficient glandular function but to precocious function. The onset of sex function influences the closure of the epiphyses and if this occurs too early in life, dwarfism results. Clinically, the precocious sexual development is important in differentiation from other forms of dwarfism. The extremities are involved more than the trunk, resulting in a disproportion of these two parts. Mentality is not influenced.

Thyroid dwarfism (cretinism) is due to underfunction of the thyroid gland during prenatal life. Roentgenograms will disclose marked delay and retardation in bone growth. If untreated, cretins are dwarfs with retarded mentality and a clown-like intelligence. Treatment consists of thyroid medication, but since the disease has its incipiency in prenatal life, complete restoration of the individual to normal is not usually obtained.

Infantile hypothyroidism differs from cretinism in that the insufficient thyroid function appears after birth or during the first year of life. It results in similar retardation of growth, but because the body was normal at birth, treatment may result in a return to normal and these children may grow into normal adults.

Mongoloid dwarfism is recognizable in most cases at birth and is characterized by generalized retardation of skeletal, body, and mental development. In infancy and early childhood these children frequently are mistaken for cretins. Heredity plays no part as a causative factor. The physiognomy shows great similarity to that of the mongoloid races.

Pineal dwarfism is extremely rare. Questionable clinical evidence exists that disturbance of the function of the pineal may cause precocious sexual development with early closure of the cartilaginous caps on the long bones. This causes short extremities and a dwarfed appearance. LESTER W. PAUL, M.D.

Infectious Spondylitis. Ernst Lyon. Schweiz. med. Wchnschr. **71:** 200–202, March 1, 1941.

As an increase in infectious diseases followed the first World War, it seems probable that a similar increase will follow the present conflict. Metastatic infection of the spine has been observed in almost all types of infection. According to Quincke, infections which produce swelling of the spleen are particularly prone to metastasize to the spine (typhoid, paratyphoid, relapsing fever, brucellosis). It may be involved, also, in scarlet fever, measles, smallpox, grippe, and after pneumococcic, streptococcic, and gonococcic infections. It is noteworthy that the spine is actually the most common site of bone metastasis from infections.

In contrast to other bone infections, the acute forms of which may run a very hectic course, infections of the vertebrae tend to be subacute or chronic. They generally appear in the convalescent period; males are usually affected, and adolescence is the age of predilection. Of the symptoms, pain in the region of the affected vertebra and soft tissue swelling are the most prominent. Spasm of the muscles of the spine and back is present. Loss of mobility and root pains are almost never absent. The slightest motion aggravates the pain. Fever may be present or absent. Gibbus is rare, but may appear even in non-tuberculous processes. Transverse myelitis is also unusual. An old spondylitis is sometimes reactivated by pregnancy or a new infection.

Roentgen study is of special importance and may show positive findings in from two to four weeks. In typhoid spondylitis the initial changes are in the intervertebral disks, with destruction or, at times, sclerosis of the bodies as a secondary finding. In staphylococcic infections severe destruction of the body of the vertebra is demonstrable. The process need not be limited to the body or even be primary in it, but may involve the posterior arch or articular processes. There is a gradual weakening of the structure of the vertebra with final collapse. Occasionally the direct primary involvement of a disk by staphylococcic infection is observed.

Paravertebral abscesses or fistulae may develop. The latter may direct attention to the diagnosis, especially when roentgen study after the injection of iodized oil is undertaken. Abscess is relatively frequent in the spondylitis of Malta fever. This disease is of two types, one with relatively slight osteoporosis and more or less periostitis, with no changes in the disks; the other with extreme destruction of both disk and body, and abscess formation. Differentiation of these cases from tuberculosis is important because the course is relatively rapid and the outlook good.

In the late stages healing with fusion of several bodies or with kyphosis may occur. It is not always easy to distinguish the roentgen appearance of the healed stage from that of healed fracture or Kümmel's disease. Some stages may be confused with osteochondritis.

Treatment should be conservative, with protracted bed rest. In severe cases this should continue until pain disappears and reparative changes are evident in the roentgenogram. Sometimes plaster casts or braces may be used to advantage. Various forms of drug or serum therapy are to be employed as indications arise. Radical therapy by laminectomy may be required if transverse myelitis arises or to remove the lesion when it is in the posterior arch. An abscess due to Malta fever will progress rapidly to healing if aspirated two or three times. LEWIS G. JACOBS, M.D.

Clinical Gout. John H. Talbott. Rocky Mountain M. J. **38:** 186–196, March 1941.

Gout is a metabolic disease of unknown etiology, associated with an increased production of uric acid in the body. Although gout produces symptoms principally in males past the age of forty, it may develop in females and the first attacks of joint pain may occur as early as the first or second decade. The disease does not progress into the classical stage of tophaceous gout until many years have elapsed and it does not belong in a category with other forms of deforming arthritis until the last manifestations have appeared.

The familial incidence of gout is high, a fact which may be helpful in reaching a decision as to the diagnosis. Periodic attacks of acute joint pain with complete re-

lief from symptoms between attacks are typical in the earlier stages. The appearance of the affected joint suggests a septic process, and not infrequently the joint has been aspirated. As the attack subsides, pitting edema may be observed, and later, desquamation.

In the field of uric acid metabolism, Wollaston was the pioneer. In 1797 he reported the identification of sodium urate crystals from tophi. Some time later Garrod extended this observation and noted an increased concentration of uric acid in the blood. His "thread test" represents an important milestone in the history of the diagnosis of the malady. The classification of uric acid as a purine body by Fischer completed this phase of the pathologic physiology.

Except for the joint changes, the only complication in patients with gout which requires clinical consideration is renal insufficiency. Sodium urate is precipitated in the tubules and this process may lead to urate calculi or to progressive renal damage.

The diagnostic triad of subcutaneous tophi, punched-out areas in the bones, and an increased concentration of uric acid in the serum may be met with in typical cases. Subcutaneous tophi may be confused with the nodules of rheumatic fever, rheumatoid arthritis, Heberden's nodes, gangliomas, calcium deposits such as occur in calcinosis, and bunions. If the suspected tophus is small and a sinus has not developed, a small amount of material may be removed and examined on a glass slide for the presence of urate needles. The upper range of serum uric acid for normals is about 6.0 mg. per 100 c.c. On the roentgenogram, punched-out areas are characteristic but these may also be seen in rheumatoid arthritis, and with chronic trauma to joints such as may occur in hallux valgus.

The author concludes with a thorough discussion of treatment. PERCY J. DELANO, M.D.

Sciatic Pain in Low-Back Derangements: Its Incidence, Significance and Treatment. A Symposium. J. Bone & Joint Surg. **23:** 407–481, April 1941.

No attempt to abstract this presentation of eleven papers by distinguished authors will be made. All phases of the subject of sciatic pain in low-back derangements are thoroughly dealt with and the cause and correction suggested. Time consumed in thoroughly digesting these works will be well spent and pay ample dividends. The subject is timely and well presented.

JOHN MCANENY, M.D.

Calcification and Ossification. M. R. Urist and F. C. McLean. J. Bone & Joint Surg. **23:** 283, April 1941.

This is a report of an extensive investigation into the process of calcification and ossification in rats. A previous paper described calcification in normal rats; the present one discusses the process of callus formation and calcification in fractures of rachitic animals. Rachitic rats were studied because here calcification begins late and the process of osteogenesis can be studied apart from calcification.

In the presence of rachitis healing of fractures begins as in normal rats except that the process proceeds in the complete absence of calcification in the newly formed tissues for the first ten to fifteen days. The first reaction following fracture is inflammatory, followed by the formation of fibrocartilaginous callus in and around the fracture. In the early stages there is no difference from normal healing except for the absence of calcification. There is the same osseous tissue formation under the periosteum and endosteum advancing toward the callus mass. After the fourth or fifth day a difference is noticed. The intramembranous bone formed under the periosteum and endosteum, and invading the fibrocartilaginous callus begins to lag, resulting in faulty and incomplete transformation into osseous tissue, and also permitting the callus to become encapsulated in dense connective tissue and fibrocartilage.

If calcification is induced in rachitic rats before the fourth or fifth day, callus formation proceeds normally, but if the calcification is delayed until after encapsulation of the callus, the process is the same as if no calcium were available.

It is observed that in the absence of calcification the healing process is both retarded and transformed into a rachitic type of response. J. B. MCANENY, M.D.

THE GENITO-URINARY TRACT

Increasing Density of the Renal Shadow During Excretion Urography. A Sign of Acute Ureteric Obstruction. S. Nowell. Brit. J. Radiol. **14:** 138–143, April 1941.

Three case reports of ureteral obstruction with increasing density of the shadow of the kidney on the affected side during excretion urography are given, with reproductions of the roentgenograms. The progressive increase in density was due to the accumulation of dye in the kidney as a result of back pressure. This observation is important, as it indicates that the kidney is functioning. SYDNEY J. HAWLEY, M.D.

GYNECOLOGY AND OBSTETRICS

Radiological Studies of the Sella Region in Gynecology. Ettore de Bernardi. Radiol. med. **28:** 125–140, March 1941.

Knowing the influence of the pituitary gland on the gonads, de Bernardi investigated roentgenologically the anatomical variations in the basal region of the skull in the female, placing special emphasis on the sella and sphenoid sinuses. Studies were made on normally menstruating females and on others suffering from various menstrual irregularities, as well as on sterile females and young girls who had never menstruated. From his investigations the author concludes that certain changes, especially in the sphenoid sinuses, are present in a sufficient number of persons to suggest that abnormal pituitary function is primarily responsible for both excessive and scanty menstruation.

A. MAYORAL, M.D.

Interpretation of Overlapping of Cranial Bones in the Fetus. L. Billing. Acta Radiol. **22:** 277–280, March 1941.

Basing his conclusions on experiments with glass phantoms (hemispheres), Billing demonstrates that small vertical changes in the level of two adjoining glass shells may simulate marked overlapping in the roentgenogram. A vertical displacement of 0.5 cm may result in a 4.0 cm. overlapping in the roentgenogram.

The reliability of the so-called Spalding sign for fetal death *in utero*, *i.e.*, more than 2 cm. overlapping of the cranial bones according to Zuppinger (in Lehrbuch der Röntgendiagnostik, edited by Schinz, Baensch, and Friedl, Leipzig, Georg Thieme, Ed. 4, 1938) must therefore be seriously questioned.

ERNST A. SCHMIDT, M.D.

THE SPINAL CORD

Myelographic Diagnosis of Intramedullary Spinal Cord Tumors. A. Earl Walker, Charles M. Jessico, and A. W. Marcovich. Am. J. Roentgenol. **45:** 321–331, March 1941.

In 6 cases of intramedullary spinal cord tumor verified by operation, in which lipiodol myelography was

used, certain findings which appear to be characteristic were observed. The primary characteristic is a partial block with a lateral displacement of the lipiodol so that it lies as a streak or streaks along the pedicles of the vertebrae. A second feature is the presence of a small lateral triangular protrusion from the streak between adjacent pedicles, due to the filling of the nerve sheath with the contrast material. To be pathognomonic, the laterally displaced beaded columns of lipiodol must maintain this position for several segments of the spinal cord, since intraspinal tumors usually extend for a considerable distance in contradistinction to extramedullary tumors. If a block occurs within one or two segments only, no differentiation can be made.

Numerous illustrations are shown and complete case histories are presented. S. M. ATKINS, M.D.

THE CIRCULATORY SYSTEM

Phlebographic Examination of the Lower Leg by Contrast Injection of a Subcutaneous Vein. Knut Lindblom. Acta Radiol. **22:** 288–296, March 1941.

The author describes his technic for phlebography of the lower leg, which he considers valuable in cases of varices and thrombosis. About 20 c.c. of a 35 per cent solution of Perabrodil are injected into a subcutaneous vein of the foot, generally a vein on the dorso-medial aspect of the big toe. Roentgenograms are taken immediately, half a minute, two minutes, and sometimes four minutes after injection. Between the exposures active motion of the extremity is advisable. The injections are done, as a rule, with the patient erect. X-ray views are taken in either the sitting or lying position with the lower leg in hanging (vertical) position. Angulation of the knee improves the roentgenographic conditions. Illustrative phlebograms are reproduced. ERNST A. SCHMIDT, M.D.

Circulatory Effects Following Intravenous Administration of Pitressin in Normal Persons and in Patients with Hypertension and Angina Pectoris. Ashton Graybiel and R. Earle Glendy. Am. Heart J. **21:** 481–489, April 1941.

One tenth of a cubic centimeter of pitressin—dilution 1:1,000—per kg. body weight per min. was administered intravenously for thirty minutes to one hour, to 9 normal persons, 4 patients with essential hypertension, and 2 with severe coronary heart disease. Although marked gastro-intestinal symptoms followed and vasoconstrictions occurred, involving minute vessels and large arteries but not the arterioles, no significant changes in the pulse rate, blood pressure, metabolic rate, and cardiac output were observed. Anginal pain was not produced in any of these patients. A minute amount of adrenalin given to one of the patients with severe coronary heart disease produced anginal pain. It would appear that therapeutic doses of pitressin may be given without fear of cardiovascular accidents.
WM. H. GILLENTINE, M.D.

MISCELLANEOUS

Cysticercus cellulosae—Its Radiographic Detection in the Musculature and the Central Nervous System. J. F. Brailsford. Brit. J. Radiol. **14:** 79–93, March 1941.

The adult parasite, Tenia solium, lives in the intestine of man. Eggs are passed in great numbers in the feces. If these ova are swallowed, as they may be as a result of contamination of water or food supplies, the embryos gain access to the blood stream and are carried to all parts of the body. The embryos develop into Cysticerci in the connective tissues chiefly of the muscle and the central nervous system. The cysts reach full development in about 110 days. They measure 3/8 by 1/4 inch. After four to five years the encysted embryos die and undergo coagulation necrosis, while the cysts become calcified. At this stage they may be identified in the muscles and sometimes in the eye. They are difficult to demonstrate in the central nervous system because of the overlying bone. Among animals the pig is chiefly infested. Numerous illustrations are included. SYDNEY J. HAWLEY, M.D.

Coccidioidal Granuloma: Brief Review with Report of a Case of Meningeal Involvement. Winchell McK. Craig and Malcolm B. Dockerty. Minnesota Med. **24:** 150–154, March 1941.

For the past fifty years the study of pathogenic yeasts and fungi has held the attention of the botanist, the medical mycologist, the dermatologist, the medical internist, the surgeon, and the pathologist. Among these pathogenic fungi, Coccidioides holds a prime position from the pathologic and mycologic standpoints In addition, the disease it produces in man has a peculiar geographic distribution.

Wernicke, in 1892, described a case of dermatitis with abscesses, encountered in Buenos Aires, from which protozoan-like organisms were obtained. Death occurred, and later writers gave a detailed account of the lesions. A similarity between the organism and the blastomyces was pointed out. Later case reports began to indicate the San Joaquin Valley in California as a spot which might appear to be an endemic focus.

In 1929, Dickson showed conclusively that infection occurred *via* inhalation of chlamydospores produced in the vegetative phase and that the incubation period was about nine days. In the period from 1929 to 1938 this same author made a discovery which opened up a new field for the study of coccidioidal infection. For years the residents of San Joaquin Valley had experienced epidemics of what was locally named "valley" or "desert" fever. This self-limited illness took the form of a severe influenza-like infection of the upper part of the respiratory tract with chills, fever, cough, and expectoration. In 80 per cent of the cases, within eight to fifteen days of the onset, lesions simulating those of erythema nodosum appeared on the extremities. Dickson cultured sputa from a number of these cases and found Coccidioides in more than 70 per cent. In only one of 350 cases of valley fever observed within a period of eighteen months did the disease progress to the stage of generalized dissemination. This patient died of coccidioidal meningitis.

That valley fever is only one manifestation of the disease cannot be too strongly stressed. The general mortality rate of the disease, including the cutaneous form, and excluding valley fever, is approximately 50 per cent. At necropsy the lungs are practically always involved but almost every organ of the body at one time or another has been reported as the seat of metastatic lesions. Apparently both blood and lymph participate in the general dissemination. In all of the seven cases of involvement of the central nervous system which have been reported the disease was fatal; basilar lesions have been present in all instances, and, in several, meningeal involvement of the cervical portion of the spinal cord.

There follows the report of a case seen at the Mayo Clinic. The disease began with headache and general lethargy, ran a course of four weeks, with a fatal termination. The symptoms were those of meningoencephalitis.

A mass dissected from the left cerebellar lobe, on staining with polychrome methylene blue, presented at once the features of an acute inflammatory process. Occasional giant cells were seen and tuberculosis was considered as a possibility, though the acuteness of the inflammatory process seemed rather unusual. Study of the fixed frozen sections stained with hematoxylin and eosin revealed an acute and subacute inflammatory reaction with micro-abscesses. Within these tiny abscesses were seen round to oval doubly contoured

refractile bodies varying in diameter from 8 to 15 microns. Occasional lanceolate forms were observed. Most of these bodies were filled with minute, round, spore-like structures.

The lungs contained multiple indurated grayish-red nodules with caseous centers; these proved to be nodules of coccidioidal granuloma.

The patient, a resident of Iowa, had spent several weeks in the San Joaquin Valley immediately prior to the onset of the disease. PERCY J. DELANO, M.D.

TECHNIC

A Research into the Physical Factors Concerned in Indirect Radiography. Paper I. The Optimum Combination of Film and Fluorescent Screen for Use in Indirect Radiography. B. Stanford. Brit. J. Radiol. **14:** 128–135, April 1941.

All combinations of eleven different films and five different fluorescent screens were tested. Both the conditions of exposure and development of the film were standardized, each film being developed to a gamma of 1.0, gamma being defined as

$$\frac{\text{density-range of recorded image}}{\text{density-range of subject}}.$$

The results are recorded in tabular form and are too complex to be abstracted satisfactorily. In general, the best results were obtained with a blue emitting screen and single-coated x-ray film, or a yellow-green emitting screen with a high-speed panchromatic film.
SYDNEY J. HAWLEY, M.D.

Experiments in X-Ray Screen Photography with Control Direct Radiographs. K. C. Clark, G. R. M. Cordiner, and P. Ellman. Brit. J. Radiol. **14:** 54–62, February 1941.

Studies were made both with direct radiography and by photographing the screen image with 35 mm. film on over 300 subjects. It was found that it was most important that the camera be in exact focus. The addition of a stationary grid improved the results. Because of the diffusion of the light from the screen the grid lines are not visible. The addition of the grid requires an increase of 20 kv. in the x-ray exposure. The direct films and the miniature films were made with the same tube and apparatus.

The findings as reported from the two examinations were in agreement except in eight instances. The direct examination revealed a lesion which was unsuspected in the miniature examination only once. In four cases the miniature film revealed what was thought to be a lesion, but it was not found on the large film, but in two of these the result of the miniature examination was not definite. In three cases the observations on the miniature films were indefinite, and the exact nature of the disease was not identified until the large film was examined. SYDNEY J. HAWLEY, M.D.

A Reflecting Screen Facilitating the Removal of Foreign Bodies and Positioning in Radiography. H. Miller. Brit. J. Radiol. **14:** 77–78, February 1941.

A reflecting screen mechanism is briefly described. Its advantage is that it leaves space above the operating field clear for the instruments and manipulations of the surgeon. SYDNEY J. HAWLEY, M.D.

Demonstration of Tumors, Non-Neoplastic Disease, and Foreign Bodies in the Neck and Chest by Body Section Roentgenography (Planigraphy). Barton R. Young. Pennsylvania M. J. **44:** 713–717, March 1941.

Planigraphy is useful in visualization of the upper respiratory tract to demonstrate disease processes that are not otherwise satisfactorily shown. It is particularly valuable in demonstrating the size and stenotic effect of a tumor of the larynx in the anteroposterior view, since the spine does not interfere with visualization.

Foreign bodies in the neck are much more readily visualized by planigraphy. It is also useful in the chest when a foreign body is surrounded by an atelectatic lung, and as the depth of the section that contains the foreign body is known its localization is much more easily accomplished.

Tumors of the lung may be discovered within atelectatic or consolidated portions of the lung, and areas of fluid may be delineated between the lobes.

Stenosis of a bronchus due to a tumor and the position of the tumor in relation to the bronchus may also be demonstrated by planigraphy. Small cavities may be found in tuberculosis where they cannot be seen in ordinary films, and cavities can be visualized in lungs that have been treated by collapse therapy or thoracoplasty.

Films are shown illustrating the conditions described.
JOSEPH T. DANZER, M.D.

Removal of Iodized Oil by Lumbar Puncture. C. S. Kubik and A. O. Hampton. New England J. Med. **224:** 455–457, March 13, 1941.

The greatest objection to the use of iodized oil in the spinal canal has been its irremovability. The authors have perfected a method of removing the opaque oil by inserting a spinal puncture needle through a lumbar interspace, usually the third or fourth, and with a small syringe attached withdrawing the oil under fluoroscopic control. By this method all the oil can be withdrawn and the need for opening the spinal meninges at operation is eliminated.

Two points of caution are stressed. The needle should be inserted in the mid-line and excessive suction should never be employed. A stop in the flow of the oil is due to obstruction and can be overcome by rotating the needle slightly.

Lately the authors have been introducing the oil and, without extracting the needle, localizing the lesion; then withdrawing the oil by syringe.
JOHN MCANENY, M.D.

Evolution of the X-Ray Tube. Frank C. Hoecker. Southern M. J. **34:** 280–284, March 1941.

A condensed illustrated article featuring the early and fundamental changes in design of x-ray tubes before the advent of the Coolidge tube. This article should be read in its complete form as it does not lend itself to abstracting. Those unfamiliar with gas tubes will find it instructive and interesting.
JOHN M. MILES, M.D.

RADIOTHERAPY

MALIGNANT CONDITIONS

Limitations of Biopsy in X-Ray Therapy. Ff. Roberts. Brit. J. Radiol. **14:** 144–145, April 1941.

If biopsy is done because the clinical examination fails to be sufficiently characteristic, it is justifiable. Biopsy is done too many times, however, when the clinical examination shows the condition to be a malignant tumor. This is usually for the purpose of grading the tumor, or for microscopic proof because it may be desired in the future to report the case. Because biopsies are not always positive proof, and because they do not reveal the biological condition of the patient or the tumor, and because the grading does not furnish an accurate basis for prognosis, the author feels that these biopsies are not often justifiable. SYDNEY J. HAWLEY, M.D.

Peroral Roentgen Treatment of Malignant Tumours. Bertil Ebenius. Acta Radiol. **22:** 194–201, March 1941.

The author discusses the history and principles of peroral contact therapy and describes and illustrates a treatment device (consisting of a "master cylinder" and a set of inserts) which has been successfully used at the Stockholm Radiumhemmet for the past five years. The problem of fixation has been solved by molds of dental compound which are adapted to the jaw, corresponding to the site of the teeth and alveolar processes. Control with optical instruments appears superfluous. Good fixation is of paramount importance and the tumor to be treated should be so located that the peroral cylinder can be directly applied to it; tumors of the base of the tongue and the lower portion of the mesopharynx are therefore unsuitable for this form of therapy. ERNST A. SCHMIDT, M.D.

Radiologic Treatment of Epulis. Sven Roland Kjellberg. Acta Radiol. **22:** 202–216, March 1941.

From 1922 to 1938, 109 cases of epulis were treated in the Radiumhemmet of Stockholm. In only 4 of these cases was x-ray therapy employed. In the remainder of the cases radium was applied, either in the form of teleradium therapy or brachyradium therapy (implantation of radium needles or superficial application of tubes and needles). The response of epulis to radiation depends on its histologic structure. The more vascular the tumor, the better the result. In the majority of cases, radiation therapy was combined with surgery or electro-endothermy. Over one-half of the patients remained free of symptoms five years and more after treatment. In 9 cases recurrences were seen: in 5 cases, or 33 per cent, of angiomatous epulis; in 2 cases, or 5 per cent, of giant-cell epulis; in 1 case, or 8 per cent, of epulis with mesenchymal tissue without giant cells. [The author does not account for the ninth case.] It is of interest that angiomatous epulis occurred almost exclusively in female patients (93 per cent), most frequently in connection with pregnancy.

ERNST A. SCHMIDT, M.D.

Results of Radiotherapy of Hypopharyngeal Cancer at the Radiumhemmet, Stockholm, 1930–1939. Hugo E. Ahlbom. Acta Radiol. **22:** 155–171, March 1941.

The treatment of choice according to Ahlbom in hypopharyngeal cancer is x-ray therapy, occasionally combined with smaller doses of teleradium, though the latter is primarily reserved for laryngeal or oral cancer. The x-ray treatment, as a rule, is given over two lateral fields, about 8 to 10 cm. in diameter, extending from the angle of the mandible to or beyond the clavicle. The total skin doses over these fields amount to 3,000 to 3,200 r, including secondary radiation, administered in daily doses of 325 to 350 r (170–180 kv., Thoraeus filter, 60 cm. distance). In some cases irradiation through a posterior field is given (total dose 1,000 to 2,000 r), although the fact that spinal cord degeneration occurred in 4 cases of posterior field irradiation indicates the need for utmost caution. Generally the attempt is made to reach a tumor dose of 5,000 to 6,000 r over a period of twenty to thirty days.

A total of 235 patients were treated by this method from 1930 to 1939 at the Stockholm Radiumhemmet. The five-year survivals amounted to 7 per cent. The importance of intensive irradiation for this type and localization of tumor is emphasized.

ERNST A. SCHMIDT, M.D.

Transthoracic Roentgen Treatment of Cancer of the Esophagus. Magnus Strandqvist. Acta Radiol. **22:** 172–193, March 1941.

During the years 1936 to 1939, a total of 36 cases of cancer of the esophagus were treated at the Stockholm Radiumhemmet. The youngest patient was forty-six years of age, the oldest seventy-six. Twenty-three patients were men, 13 women.

The average tumor dosage was 5,000 r within a certain period, *e.g.*, forty days, with uniform fractionation. The appearance of the tumor was usually checked by esophagoscopy and biopsy ten days after inception of the treatment, *i.e.*, after an initial tumor dose of 1,000 to 1,500 r. The skin doses per treatment and day were in most cases very large (up to 800 r per treatment). As a rule, six portals of entry were employed.

A survey taken in January 1941 showed that of the 36 patients 32 had died within one year after treatment (18 directly of cancer; 5 within three months, of perforation, probably a treatment complication; 9 within nine months, from other complications, mostly in the lungs). Two women lived, free of symptoms, for over two years. One of these died of myocarditis without clinical evidence of cancer. The cause of death in the other case was unknown, possibly metastasis. One woman is still alive and free of symptoms two years after treatment; one man is still alive and free of symptoms almost three years after treatment.

The author stresses the importance of detailed reports with regard to daily and total tumor doses, number of treatment days, and other relevant factors in order to arrive at more definite conclusions concerning the optimum therapy dosage and technic. Illustrations are included. ERNST A. SCHMIDT, M.D.

Therapy of Carcinoma of the Esophagus. Ludwig Bayer. Monatschr. f. Krebsbekämpf. **4:** 73–85, April 1941.

Since 1935 there have been treated with external irradiation 8 cases of esophageal carcinoma (7 men, 1 woman) and 1 sarcoma. In 6 of the cases, the tumor disappeared grossly within a short time. Two patients died of cachexia, 3 of metastases, 1 from pericarditis, and 1 from a possible lung edema. The average life duration was 8.14 months. X-ray therapy was used exclusively: 180 kv., 5 ma., "Holfelder method." Two fields were treated daily, rotating the ports, with skin doses of 330 r. [The author does not mention the size of fields or total dosage per port.] Seven fields were used: 2 anterior and 2 posterior oblique, 2 lateral and 1 straight anterior-posterior.

The author concludes that in his cases the extreme radiosensitivity of the tumor was undoubtedly a part of the very malignant picture.

MAURICE D. SACHS, M.D.

Sarcoma of the Esophagus—Symptom-Free Fifteen Months after X-Ray Therapy. Ludwig Bayer. Monatschr. f. Krebsbekämpf. **4:** 86–87, April 1941.

A seventy-year-old man was admitted to the hospital because of loss of ability to swallow fluids or liquids. On fluoroscopy and further study of the roentgenograms a diagnosis of sarcoma was made by exclusion. No esophagoscopy or biopsy was done because of the patient's age.

X-ray therapy was given to 7 fields: 2 anterior and 2 posterior oblique, 2 lateral, and 1 straight anterior-posterior, the primary beam being directed toward the tumor bed. A total skin dose of 3,212 roentgens was given. The author is not explicit as to r per field, time interval, or field size, and it is not clear whether the 3,212 r represent the total dose per field or the total for all the fields.

After fourteen days the patient was able to swallow fluid and soft food. Subsequent roentgen examinations revealed that the esophagus was within normal limits, and no trace of tumor was present after fifteen months. The author adds that the radiosensitivity of the tumor to small doses is further proof that the lesion was a sarcoma rather than a carcinoma.

MAURICE D. SACHS, M.D.

X-Ray Treatment of Inoperable Carcinoma of the Rectum without Colostomy. J. F. Roberts. Brit. M. J. **1:** 357–359, March 8, 1941.

This article shows a positive conviction on the part of the author that colostomy in non-obstructive carcinoma of the rectum is of doubtful value. The question is discussed from the standpoints of prolongation of life, alleviation of suffering, and effect on tumor growth. Figures are presented showing a possible increase in life expectancy averaging 4.8 months, the value of which is negligible. The distressing features of hemorrhage and mucous discharge are not relieved by colostomy and in the usual case the patient finds no satisfaction in his new mode of evacuation. The author feels, furthermore, that tumor growth in this region is not retarded.

For irradiation x-rays are preferred to radium. A series of 20 cases is reviewed; the findings indicate definite improvement in condition and notable prolongation of life. Q. B. CORAY, M.D.

The Radiumhemmet Experience with Radiotherapy in Cancer of the Corpus of the Uterus: Classification, Method of Treatment, and Results. J. Heyman, O. Reuterwall, and S. Benner. Acta Radiol. **22:** 11–98, March 1941.

This monograph on radiotherapy of cancer of the corpus uteri is the leading article in a special Gösta Forssell Anniversary Number of the Acta Radiologica issued in commemoration of Forssell's 65th birthday and his retirement as Professor in the University of Stockholm.

The following summary given by the authors may serve as an abstract of this very comprehensive article, which should be read in the original [it is in English] by all interested in this subject.

"A review is submitted of the Radiumhemmet experience in radiological treatment of cancer of the uterine corpus including a report on the clinical and histological grouping adopted at the Radiumhemmet in the classification of uterine carcinoma.

"The histological classification, according to which the cases are separated in 12 groups, is described by Reuterwall.

"In the chapter on the clinical classification three types of cases are mentioned in which the cancer might have originated from the endometrium of the corpus but the including of which among the corpus cases would ruin an exact evaluation of the results obtained. Three groups, which are called cancer corporis et colli uteri, cancer uteri et ovarii, and cancer pelvis, are excluded in the calculation of the results.

"With a view to an exact classification the fractional curettage has been made a routine method in the examining of the corpus cancer cases. The method is described in detail. A detailed account is given of the Radiumhemmet present method of treatment, *i.e.*, the packing of the uterine cavity with a number of uniform irradiators. The position of the irradiators in the uterus and the different instruments used in packing are illustrated by a number of roentgenograms and photographs. The method of packing was introduced in 1932 since the results obtained by the previous method had proved to be less satisfactory. In its present shape the method has been employed in 1939 and subsequent years.

"The physical experiments necessary for determining the required dose are described by Benner.

"The result of the treatment is estimated on a series of 402 cases observed for a period of 5 years. The absolute cure rate, the relative over-all cure rate, and the group cure rates are presented; cases operated upon after failure of radiotherapy and cases registered as probably cancers are mentioned separately.

"1934 was the first year during which the method of packing was employed in all suitable cases. The result of radiotherapy combined with hysterectomy in case of failure is that 75 per cent of the number of clinically operable cases treated in 1934 were alive without evidence of the disease 5 years after the beginning of the treatment. The 5-year result obtained in these cases is 20 to 30 per cent higher than that obtained with the old technique.

"The radium treatment, combined with hysterectomy in case of failure, is recommended as the method of choice except in patients particularly well suited to surgery. Definite conclusions as to the suitability of primary radiological treatment in the last mentioned category of patients are postponed until further experience is available."

The paper is fully illustrated.

ERNST A. SCHMIDT, M.D.

Comparison of Results of Surgery and Radiotherapy in Carcinoma of the Cervix Uteri. W. R. Winterton, and B. W. Windeyer. Brit. M. J. **1:** 195–196, Feb. 8, 1941.

This article is a satisfying attempt to determine the relative values of surgery and radiotherapy in the treatment of carcinoma of the cervix. A series of 179 cases is reviewed, the criterion of effectiveness being the five-year survival rate. The type of radiation used was for the most part radium plus x-ray. Fifty-nine patients were treated surgically and 87 by radiation. The classification used was as follows: Stage 1: Limited. Stage 2: Spreading. Stage 3: Infiltrating with limited mobility. Stage 4: Massively infiltrated.

The conclusions made indicate a slight but definite superiority of radiation therapy in these cases. In Stages 1 and 2 there were 44 per cent of five-year survivals following radiation as compared with 41.3 per cent following surgery. In the Stage 3 group there was a 30 per cent survival following radiation and 27.2 per cent following surgery. There was naturally a much lower treatment mortality with irradiation than with surgery. Q. B. CORAY, M.D.

Notes on the Radiation Treatment of Cancer of the Cervix. Oliver Chance. Irish J. M. Sc. **183:** 120, March 1941.

Seemingly, carcinoma of the cervix is not as common in Ireland as in most other countries. The incidence is 6 to 8 per 100,000, while in England and Wales it is at least 12 per 100,000. This review of 201 cases classifies 18.7 per cent as Stage I, 21.9 per cent Stage II, 40.8 per cent Stage III, and 18.6 per cent Stage IV. Biopsy was done in only 92 cases, but the positive members of this group showed a greater percentage of five-year survivals than the group without biopsy, in which the disease was so advanced as to be readily recognized.

Bleeding is the usual complaint and its average duration is nine months. Married women comprised 97 per cent of the group and 88 per cent of the entire number had borne children.

Treatment consisted in thorough cleansing of the cervix and vagina, followed by cervical dilatation and insertion of radon screened with 1.5 mm. platinum. A rubber sphere containing radon, filtered through 1 mm. platinum is placed in each fornix. The total dose is about 7,500 mc. hr. One week later x-ray therapy is begun and continued three to five weeks. The dosage and procedure are not given.

Five-year survivals are as follows: Stage I, 47.3 per cent: Stage II, 27 per cent: Stages III and IV, 9 per cent. J. B. MCANENY, M.D.

One Hundred and Seventy-Seven Cases of Primary Cancer of the Vulva. Elis G. E. Berven. Acta Radiol. **22:** 99–154, March 1941.

The standardized treatment of cancer of the vulva in the Stockholm Radiumhemmet consists in removal

of the tumor tissue by electrocoagulation combined with teleradium therapy of the lymph node-bearing area, if involved, and eventual *en bloc* dissection of the nodes in suitable cases. From 1922 to 1935, 177 patients were treated according to this method. Sixty-five patients were alive and free of symptoms five years after treatment, or 36.7 per cent. This is a very decided improvement compared with the Radiumhemmet's five-year cure percentage of 13 per cent after radiation therapy alone. The postoperative mortality after electrocoagulation and surgical removal of the nodes reached 8.5 per cent. Important factors for the prognosis are early diagnosis, individual resistance, age of patient, previous treatment, local extent of tumor, and metastases.

Roentgen treatment of the inguinal node regions was abandoned in 1929, when the Radiumhemmet came into the possession of 3 grams of radium. Only in the presence of extensive lymph node metastases was x-ray treatment over the iliac fossa or over a posterior field added in this series. The teleradium technic now employed uses 2 squares of about 5 cm. diameter in each inguinal region. The patient receives a daily dose of 6 gram-hours, corresponding approximately to 900 r at an intensity of 7 1/2 r per minute. The same square is treated every fifth day. The 3 cm. depth dose is about 45 per cent of the skin dose. In stage I of lymph node involvement (small, movable nodes), the patients receive a total of 2,700 to 3,600 r per square within a period of twelve to sixteen days. In stages II and III (large hard nodes with adjacent infiltration and enlarged fixed nodes, probably inoperable metastases), 3,600 r are applied per treatment square.

Illustrations in black and white and color are included. ERNST A. SCHMIDT, M.D.

Symptomatic Leukemia. H. G. Hadley. Brit. J. Radiol. **14:** 113–114, March 1941.

Symptomatic leukemia may occur in association with malignant tumors, especially with bone metastasis, or in some infections such as pertussis. A brief review of the leukoses and the origin of the cells is given, with the blood counts in one case secondary to pertussis.

SYDNEY J. HAWLEY, M.D.

NON-MALIGNANT CONDITIONS

Naevus Epithelioma Cylindromatosus (with Special Reference to Its Radiological Treatment). Stig Erikson. Acta Radiol. **22:** 217–236, March 1941.

Since naevus epithelioma cylindromatosus is a slowly growing tumor and causes little discomfort, its treatment has received relatively slight attention. Though as early as 1912 de Beurman recommended radium therapy in these cases, most clinicians preferred surgical procedures.

Erikson describes 14 cases (8 multiple, 6 solitary) of naevus epithelioma cylindromatosus which were treated at the Radiumhemmet in Stockholm. In some of the cases, especially in those of solitary lesions, implantation of radium needles was employed (10 mg. radium each, 1 to 10 needles, depending on the size of the area, filter equivalent to 0.9 mm. lead, treatment time four to four and a half hours). In most cases the tumors disappeared entirely.

In cases of wide and scattered tumor distribution roentgen therapy was applied in doses ranging from 2,000 to 3,000 r, filtered with 1 to 4 mm. Al, over a five to eight days' period. As a rule, the smaller tumors disappeared entirely, while the larger ones only diminished in size. The familial occurrence of naevus epithelioma cylindromatosus appeared obvious. In one case, histologic examination suggested a change from naevus epithelioma cylindromatosus to basal-cell cancer. The cosmetic effect of radiation treatment was good. ERNST A. SCHMIDT, M.D.

X-Ray Therapy in Pneumonia. Fred Decker. Illinois M. J. **79:** 313–320, April 1941.

Decker gives a brief review of the various methods used to combat pneumonia in recent years, including serum therapy, chemotherapy, and x-ray therapy. He points out that inflammatory lesions which are accompanied by a large accumulation of invading leukocytes and lymphocytes are most susceptible to x-ray therapy, that such lesions require only relatively small doses of x-ray, and that a leukopenia is rarely found in pneumonia. Consequently, since pneumonic consolidation contains a large collection of leukocytes and lymphocytes, since the small dosage precludes danger to the soft tissues, and since the patient can be transported to the x-ray room or a portable unit can be used, pneumonia cases are regarded as suitable for x-ray therapy. Eighty-eight cases were treated, using 4 mm. of aluminum filtration, 140 kv., at 50 cm. distance. The dosage varied from 75 to 135 r per field, measured in air. A response was expected after a second treatment, given on the second day. Failing a response, this type of therapy was discontinued. The results obtained appear convincing. The author concludes that roentgen therapy has a definite value in many acute infections and that pneumonia should be included in this group.

WILLIS A. WARD, M.D.

IRRADIATION EFFECTS

Serum Cholesterol and Irradiation Sickness. Barbara E. Holmes. Brit. M. J. **1:** 314, March 1, 1941.

This article briefly but effectively presents a worthy effort on the part of the author to clarify the elusive situation of irradiation sickness.

The data presented were obtained by serum analysis in 11 cases under x-ray therapy. The findings are incomplete but information is available which points to the conclusion that patients who suffer no post-irradiation discomfort have a rise in cholesterol serum content and that those who have a typical gastric upset following irradiation fail to show this rise. The natural deduction is that cholesterol administered in susceptible cases will prevent radiation sickness. This treatment was effectively tried by Levy-Dorn and Bergheim.

Q. B. CORAY, M.D.

Rhythm Changes in the Heart due to Roentgen Irradiation. P. Eggers. München. med. Wchnschr. **88:** 242–244, Feb. 28, 1941.

The author reports 6 cases in which changes in cardiac mechanism occurred after irradiation of intrathoracic neoplasms. In the first case after the sixth dose of 60 per cent HED the radial pulse became irregular and an electrocardiogram showed slow fibrillation. The next day the rhythm was normal and a flat T-1 and T-3 were present. Fibrillation recurred in two days. After cessation of irradiation the heart was found to be normal in mechanism; the patient later died.

The second patient showed arrhythmia after the third dose of 60 per cent, again a fibrillation which alternated with periods of normal mechanism. In the third case the arrhythmia appeared after the fourth treatment and went on to decompensation. After complete rest an electrocardiogram showed flattening of T-1 and T-3, sinus tachycardia, and right-sided deviation. Fibrillation and supraventricular extrasystoles appeared at times. The fourth case showed damage after three treatments with 20–25 per cent to the spleen; fibrillation with ventricular extrasystoles was shown by the electrocardiogram. The fifth patient was treated through three fields, 50–60 per cent HED, and the irregularity appeared during the fourth series, this time due to extrasystoles. In the sixth patient six treatments of 60 per cent led to a total cardiac irregularity and death ensued in eight days. In all treatments

the physical factors were: 30 cm. FDS., 0.5 mm. Cu plus 1.0 mm. Al filter, 187.5 kv., 12 ma., and field size 8 × 10 cm.

In all these patients lung or splenic tumors led to irradiation of the cardiac region. The author feels that the return to normal rhythm after cessation of irradiation noted in three is a proof of the causal relationship of the latter.

An experimental study was made of the effect of irradiation on the hearts of white rats. Fibrillation did not occur although heavy radiation was administered to the heart for two and a half months. Daily treatment to the heart of a rat with 20–30 per cent HED over a 4 × 5 cm. field (other factors as above) produced no electrocardiographic change. With 40 per cent HED for a month and a half, flattening of the T waves appeared in all leads. No change in rhythm occurred.

It is possible to postulate that in the presence of a tumor an increased dose is absorbed with greater effect on the regulatory nerves of the heart.

LEWIS G. JACOBS, M.D.

EXPERIMENTAL STUDIES

Effect of Gamma Radiation on Cells in Vivo. Part III. Spaced Radiation. F. G. Spear and A. Glücksmann. Brit. J. Radiol. **14:** 65–76, February 1941.

The effect of gamma radiation at various intensities and with various spacing of the dose, on the brain and eye of the tadpole was studied. The object was to compare the effect of continuous and spaced radiation on mitosis and degeneration over a period of three weeks. The irradiation was given in the following manners: (1) 268 r in a single exposure at 3.8 r/m; (2) 536 r in a single exposure at 0.34 r/m; (3) 536 r in a single exposure at 2.05 r/m; (4) two exposures of 268 r at 3.8 r/m separated by an interval of 24 hours; (5) two exposures of 268 r at 3.8 r/m separated by 2 hours; (6) a single exposure of 536 r at 3.8 r/m and (7) two exposures of 268 r at 3.8 r/m separated by an interval of 10 days.

In each instance there was a decrease in mitosis followed by a rise in the number of dividing cells, but there was a relative increase in the prophase count. The metaphase count rose eventually and reached the value of the prophase count at about the time degeneration disappeared, except in the sixth experiment, which was anomalous. The amount of degeneration was about the same in all experiments except the seventh. In the seventh there was a large increase in destruction following the second irradiation.

These experiments, with those in Parts I and II (see Absts. in Radiology **33:**663, 1939; **35:**755, 1940) suggest that very small doses of radiation produce no change in the cells; a threshold dose prevents some cells from dividing but normal mitosis occurs later and degeneration does not occur; with larger doses, some cells reach prophase and then break down; maximum dosage in one exposure arrests mitosis in prophase with subsequent breaking down; and the maximum dosage in two exposures with optimum spacing produces almost complete cessation of mitosis and a large amount of degeneration. The time at which the second dose is given must depend upon the tissue reaction to the first. To give the second dose too soon is wasteful. For any given tissue as the dose is raised the interval between the exposures should be increased. If multiple doses of equal value are to be given, the interval between exposures might be progressively increased with advantage. SYDNEY J. HAWLEY, M.D.

Radiation and the Cell. Paul S. Henshaw. J. Nat. Cancer Inst. **1:** 277–290, December 1940.

The paper opens with an elementary exposition of some basic concepts of the structure of matter and the properties of radiation, and of the structure of cell and chromosome from a physico-chemical point of view. A distinction is drawn between functional (metabolic, nutritional, etc.) and control activities of the cell (genic and enzymatic regulation). The discontinuous action of radiation is more likely to be exerted on the control than on the functional activities, as the former are due to substances present in small amounts. The biological responses to radiation are of three types, which the author designates as (*a*) single-event action (mutations, killing of microorganisms); (*b*) multiple-event action with holistic effect; (*c*) multiple-event action, with effect manifest by degree. The events are the elementary processes of adsorption of radiation, and the first and second categories of actions are supposed to be due to production of one or more of these processes. The fact that this elementary process is an ionization, that is, a process affecting one single molecule, has suggested the possibility that biological action of radiation is due to modification of one or few entities of molecular dimensions in the cell (genes and the like).

S. E. LURIA, M.D.

Effect of Prolonged X-Radiation on the Congo Red Index of Rabbits. Cornelia Hoch-Ligeti. Cancer Research, **1:** 28–33, January 1941.

The effect on the Congo red index of total exposure of rabbits to 900–1,050 r of roentgen radiation (140 kv., distance 55 cm., filter 0.5 mm. Cu) applied in individual doses of 150 r during the course of one year was investigated. In general a decrease in the index occurred, indicating diminished power to eliminate the dye. This probably results from the adverse effects of irradiation on the reticulo-endothelial system, and is comparable, although of a lesser degree, with the effect of the carcinogenic hydrocarbons on the index. Ultrafiltrates of the blood or plasma of irradiated animals, when injected into untreated rabbits, produced no consistent alteration in the Congo red index of the latter, in distinction to normal blood, which provokes an increase and blood of an animal treated with a carcinogenic chemical, which frequently causes a decrease.

MILTON J. EISEN, M.D.

Reactions of Phycomyces blakesleeanus Following X-Ray and Gamma Radiation. Arne Forssberg. Acta Radiol. **22:** 252–259, March 1941.

Phycomyces blakesleeanus is a monocellular fungus widely used in experiments concerning phototaxia, and is very sensitive to gamma radiation. Forssberg demonstrated definite biologic reactions (retardation of growth) after application of x-ray and gamma radiation even in dosage as small as 0.001 r. After small doses the biologic effects were reversible and often followed by compensating growth stimulation. After larger doses (over 5,000 r) an irreversible process ensued. ERNST A. SCHMIDT, M.D.

A Lens for Roentgen Rays: First Experience of Its Application to Therapy. Mario Lenzi. Radiol. med. **27:** 933–944, December 1940.

Lenzi reports researches on focussing of x-rays with mica and graphite collectors or lenses constructed on the principle proposed by Pierucci. The first part of the work was directed to find out if such gadgets could be used in diagnostic roentgenology; the second sought to determine the feasibility of their use in radiotherapy. From his researches the author concludes that by the use of these lenses or "collectors" it does not appear impossible to concentrate sufficient x-ray energy at a given point to increase appreciably the quantity of radiation. A. MAYORAL, M.D.